CCDR
Canada Communicable Disease Report
ISSN 1188-4169
Volume: 35S3 December 2009

# Supplement

## Canadian Integrated Surveillance Report:

## *Salmonella*, *Campylobacter*, verotoxigenic *E. coli* and *Shigella*, from 2000 to 2004

Centre for Food-borne, Environmental and Zoonotic Infectious Diseases,

Infectious Disease and Emergency Preparedness Branch

Public Health Agency of Canada

Public Health Agency of Canada | Agence de la santé publique du Canada

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## Acknowledgments

This document would not have been possible without the dedication and hard work of many medical, public health, and scientific personnel from across Canada. Local inspectors, public and private health care workers and public and private laboratory personnel collected the initial samples and data. Provincial, territorial and federal personnel ensured that the samples and data were managed appropriately to be included in the national databases. The authors would like to especially thank the personnel from the Enteric Diseases Program, National Microbiology Laboratory, Winnipeg, the Laboratory for Foodborne Zoonoses, Guelph, the Centre for Foodborne, Environmental and Zoonotic Infectious Diseases and the Canadian Integrated Program for Antimicrobial Resistance Surveillance for the valuable input provided in compiling this report.

**Suggested citation:** Public Health Agency of Canada. *Canadian Integrated Surveillance Report: Salmonella, Campylobacter, verotoxigenic E. coli and Shigella, from 2000 to 2004.* CCDR 2009;35S3:1-50.

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# Canadian Integrated Surveillance Report:

## *Salmonella*, *Campylobacter*, verotoxigenic *E. coli* and *Shigella*, from 2000 to 2004

# Executive Summary

This is the second integrated surveillance report looking at temporal and spatial trends of selected enteric diseases in Canada from various data sources. This report focuses on the years 2000 to 2004. The pathogens described are *Salmonella*, *Campylobacter*, verotoxigenic *Escherichia coli* and *Shigella*. From 2000 to 2004, a general decline in reported rates of all four pathogens was observed in all except a few provinces. When looking at more long-term trends from 1995 to 2004, a similar decline was seen in nationally reported rates for all four pathogens. *S.* Typhimurium was the most frequently reported *Salmonella* serovar during the five-year period described, followed by *S.* Heidelberg and *S.* Enteritidis. *C. jejuni* remained the most prevalent *Campylobacter* species reported between 2000 and 2004. *E. coli* O157 comprised the majority of verotoxigenic *E.coli* isolates over these five years. *Shigella sonnei* was the most frequently reported *Shigella* species.

Hospitalizations, deaths, outbreaks and case clusters, as well as unusual isolation sites and travel-acquired infections are also explored in this report. Pathogenic *E. coli* was associated with the highest hospitalization rates over the five-year period, although *Salmonella* infections resulted in the largest number of deaths overall. Data on outbreaks and case clusters is limited to those reported to the National Enteric Surveillance Program (NESP) and the National Microbiology Laboratory (NML). *Salmonella*-related outbreaks and case clusters comprised the largest proportion of reported outbreaks and case clusters as well as the largest number of outbreak-related cases over the five-year period. Although travel history is largely under-reported, *Salmonella* infections accounted for the largest proportion of reported travel-acquired illnesses. *Salmonella* also accounted for the majority of reported isolations from non-faecal sample sources.

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# Background

This is the second Canadian Integrated Surveillance Report examining the reported trends for the top four enteric bacterial groups in Canada, based on data collected through various surveillance databases. This report focuses on the years 2000 to 2004. The surveillance data used to prepare this report were developed for different purposes and collect different data elements (see Appendix A for details). Each system has inherent limitations therefore, interpretation of data should be done with these limitations in mind (see Appendix A for more information).

In general, notification of an enteric disease case is initiated by the laboratory confirmation of a notifiable agent. There were 52 diseases identified as nationally notifiable during the 2000 to 2004 period[1]. Among these, were 11 identified as enteric, food and waterborne diseases, including the four reviewed in this report (Appendix B). The local public health unit is informed of the case by the laboratory or physician, and through subsequent follow-up, acquires detailed information about the patient and potential risk factors. These data form the basis for reports in the National Notifiable Diseases databases - Summary [NDRS] and Individual Case [NNDI]. Local and regional laboratories forward some enteric pathogens to provincial laboratories for confirmation, identification and further subtyping. Aggregate reports of isolates are sent to the National Enteric Surveillance Program (NESP) by the provincial public health or central reference laboratory in each province. Some isolates from the provincial laboratories are sent to the Enteric Diseases Program, National Microbiology Laboratory (NML) for identification and additional subtyping. Isolates from non-human sources (food, animal and environment) are sent to the Laboratory for Foodborne Zoonoses (LFZ) for isolation and subtyping. As part of the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS), human *Salmonella* isolates are sent to NML, while *Salmonella* isolates from animal and food sources are sent to LFZ, for antimicrobial susceptibility testing. Additional data sources include the Hospital Morbidity Database (HMDB) from the Canadian Institute for Health Information (CIHI) which contains data about hospital admissions from across Canada, as well as data from the Death Database of the Vital Statistics program of Statistics Canada. This later database includes cause of death data (as reported on death certificates) on all deaths in Canada. Thus, each information source provides a unique perspective on enteric diseases in Canada.

This report uses all of these data sources to describe agents, cases and outbreaks related to the top four enteric bacterial groups reported in Canada: *Salmonella*, *Campylobacter*, verotoxigenic *Escherichia coli* and *Shigella*. While the main focus of this document is to describe disease trends over time and geographic area, comparisons between the main surveillance systems collecting similar data have also been highlighted, where appropriate. For instance, the rates of infection with *Salmonella* are quite similar whether reported as National Notifiable Diseases data or as laboratory-based data. For *Campylobacter* infections, however, the rates can be quite different depending on the data source and the province/territory. No single data source is adequate to describe all the various aspects of enteric disease in Canada. Consequently, the combined interpretation of each of the data sets in this document provides a comprehensive overview and highlights the most appropriate data source for answering particular questions about trends in enteric disease reporting in Canada.

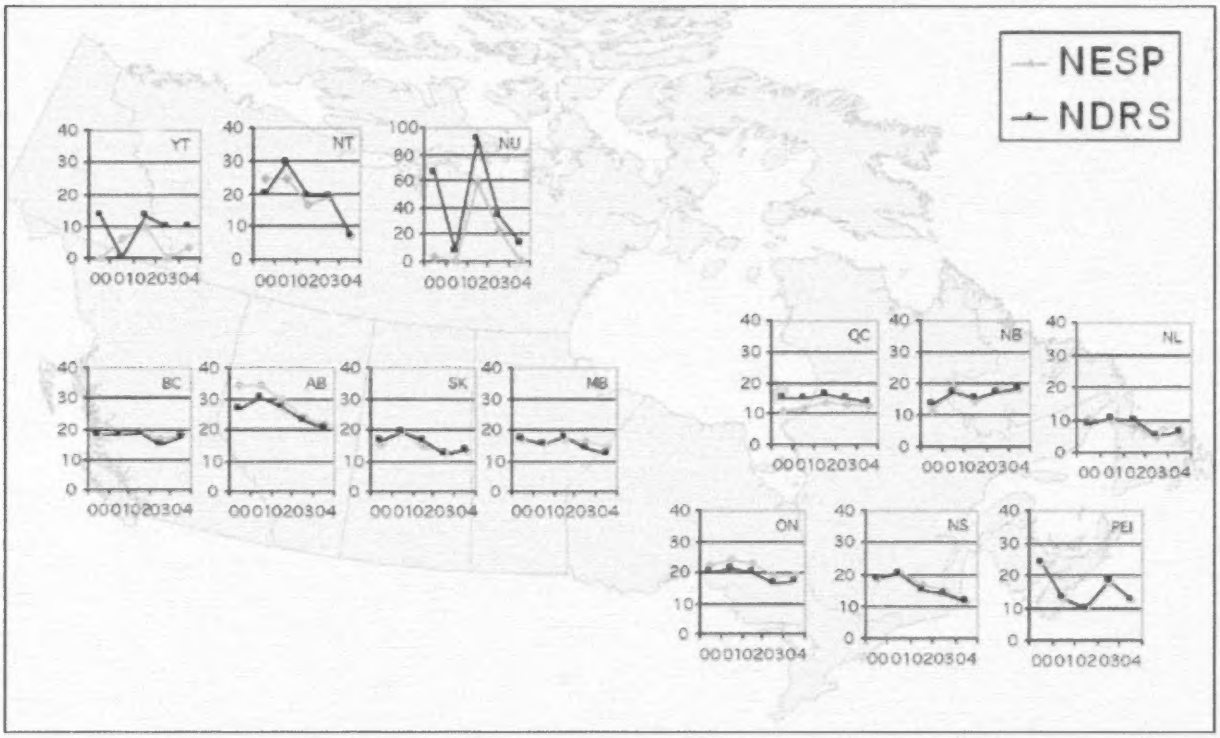
# Human *Salmonella* Cases

Between 2001 and 2004, there was an overall decrease in *Salmonella* cases reported in Canada, with 2003 and 2004 numbers being well below the level reported in 2000 (Table 1). This decline is seen in all provinces and territories, with the exception of New Brunswick (Figure 1). The low number of reported cases and smaller population base in the three territories results in greater trend variability. The two key national surveillance systems that capture information on enteric disease, the National Notifiable Disease Reporting Systems database (NDRS) and the National Enteric Surveillance Program (NESP), show a high degree of concurrence during this period. This level of agreement is expected given the high frequency with which local laboratories forward *Salmonella* isolates to their provincial or central reference laboratory for serotyping. For a description of the NDRS and NESP, please refer to Appendix A – Section 1 and 2.

**Table 1: Number of *Salmonella* cases in Canada by year and surveillance system**

| | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| **NDRS** | 5780 | 6177 | 6092 | 5185 | 5213 |
| **NESP** | 5860 | 6383 | 6256 | 5411 | 5378 |

**Figure 1: Rates of salmonellosis (per 100,000 population) as reported to the National Notifiable Disease Summary program (NDRS) and the National Enteric Surveillance Program (NESP) by province/territory, 2000 to 2004***




* Note the different scale used for Nunavut.

## Top 10 Serovars

The top 10 *Salmonella* serovars reported to the NESP from 2000 to 2004 are listed in Table 2. *S.* Typhimurium remained the most frequently reported serovar over the five-year period, while the second and third positions alternated between *S.* Heidelberg and *S.* Enteritidis. This list of most common serovars remained consistent during the period under review. Only three of the serovars recorded were not among the top 10 every year: *S.* Oranienburg, *S.* Saintpaul and *S.* ssp I 4,[5],12:i:-. Most of the *S.* Oranienburg cases reported in 2002 were linked to a multi-provincial outbreak.

**Table 2: Top 10 *Salmonella* serovars (number) from human cases, 2000 to 2004, NESP**

| | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| 1 | *S.* Typhimurium (1267) | *S.* Typhimurium (1309) | *S.* Typhimurium (1250) | *S.* Typhimurium (1104) | *S.* Typhimurium (1107) |
| 2 | *S.* Enteritidis (1192) | *S.* Enteritidis (1237) | *S.* Heidelberg (1086) | *S.* Heidelberg (1091) | *S.* Enteritidis (991) |
| 3 | *S.* Heidelberg (741) | *S.* Heidelberg (830) | *S.* Enteritidis (1000) | *S.* Enteritidis (685) | *S.* Heidelberg (942) |
| 4 | *S.* Hadar (292) | *S.* Hadar (247) | *S.* Hadar (258) | *S.* Hadar (194) | *S.* Thompson (153) |
| 5 | *S.* Thompson (256) | *S.* Thompson (225) | *S.* Oranienburg* (235) | *S.* Newport (177) | *S.* Hadar (149) |
| 6 | *S.* ssp I 4,[5],12:i:- (138) | *S.* ssp I 4,[5],12:i:- (179) | *S.* Thompson (223) | *S.* Thompson (144) | *S.* Newport (149) |
| 7 | *S.* Agona (111) | *S.* Newport (138) | *S.* Newport (197) | *S.* Agona (140) | *S.* Typhi (129) |
| 8 | *S.* Newport (100) | *S.* Infantis (119) | *S.* Typhi (112) | *S.* Typhi (128) | *S.* Agona (116) |
| 9 | *S.* Infantis (89) | *S.* Agona (117) | *S.* ssp I 4,[5],12:i:- (107) | *S.* Infantis (119) | *S.* Infantis (102) |
| 10 | *S.* Typhi (86) | *S.* Typhi (108) | *S.* Agona (103) | *S.* Saintpaul (110) | *S.* ssp I 4,[5],12:i:- (92) |

* A multi-provincial *S.* Oranienburg outbreak was identified in 2002.

**Note:** The analysis of human *Salmonella* data presented in the remainder of this report is divided into non-typhoid *Salmonella* and *S.* Typhi/ Paratyphi. *S.* Typhi and *S.* Paratyphi are host adapted serovars which primarily causes invasive infection, while the primary presentation of non-typhoid *Salmonella* (non-host adapted species) is enteric (salmonellosis).

# Non-typhoid *Salmonella* Cases

## Serovars Increasing in Frequency

The *Salmonella* serovars that showed an annual increase in reports in at least four consecutive years from 2000 to 2004 are shown in Table 3. These increases may reflect cyclical trends that are often observed among *Salmonella* serovars rather than representing a true emergence.

**Table 3: *Salmonella* serovars showing an increase in reporting frequency, 2000 to 2004, NESP**

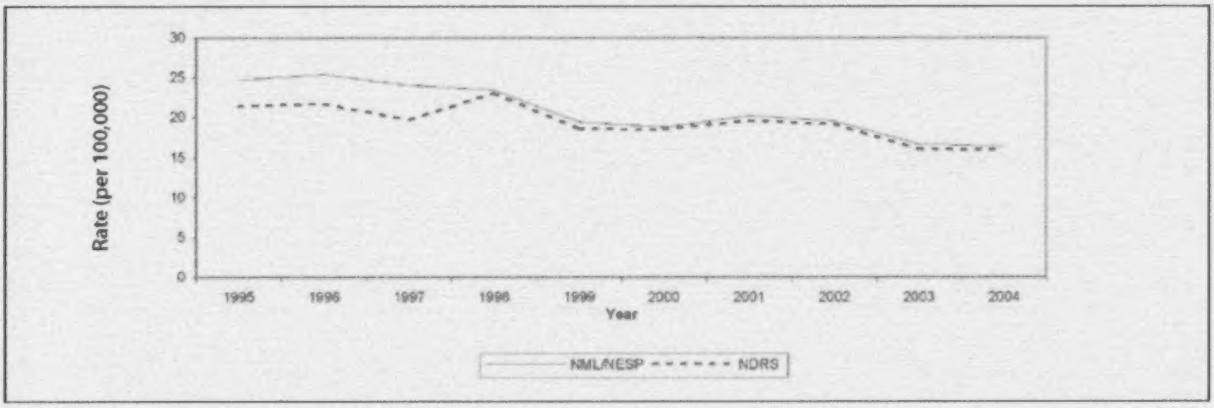
| Serovar | 2000 Count | 2001 Count | 2002 Count | 2003 Count | 2004 Count |
|---|---|---|---|---|---|
| S. ssp I 4,[5],12:b:- [1] | 35 | 42 | 64 | 62 | 49 |
| S. Anatum [2] | 19 | 32 | 39 | 41 | 18 |
| S. Bareilly | 5 | 7 | 10 | 14 | 15 |
| S. Indiana | 2 | 3 | 5 | 13 | 11 |
| S. Muenchen [3] | 28 | 36 | 43 | 55 | 43 |

[1] In 2002, 11 S. ssp I 4,[5],12:b:- infections were related to outbreaks; in 2003, 27 cases were linked to an outbreak
[2] In 2002, 20 S. Anatum infections were related to an outbreak
[3] In 2004, 9 S. Muenchen infections were related to an outbreak

## Long-term Trends

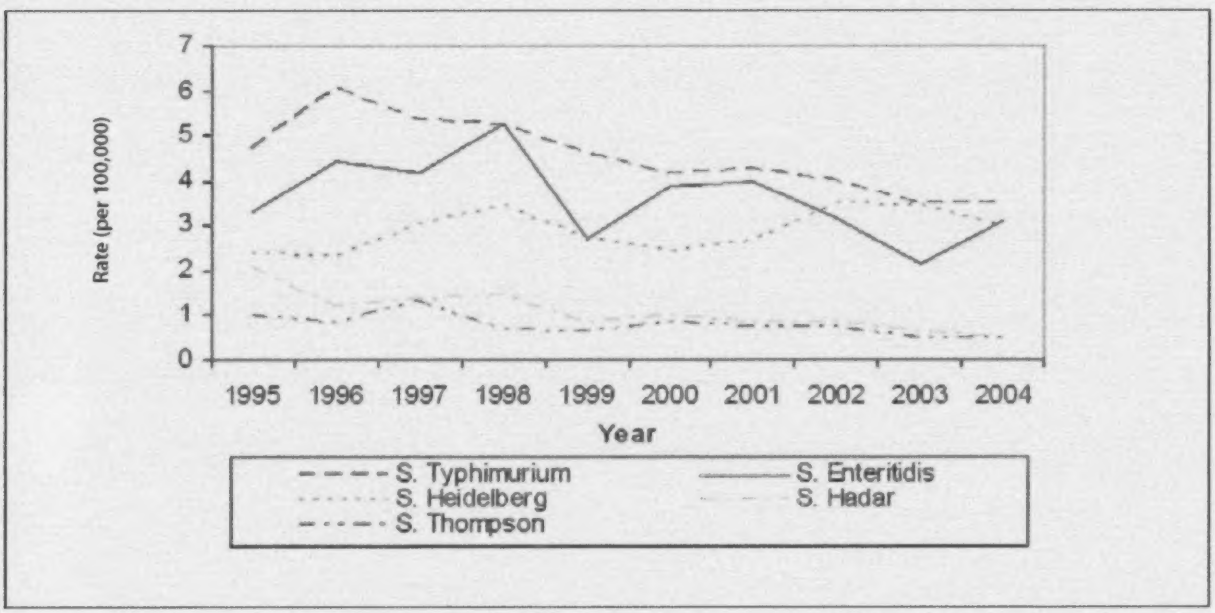
From 1995 to 2004, there was an overall decline in the national rate of non-typhoid *Salmonella* infections (Figure 2). Long-term trends of the most common non-typhoid serovars over the 10-year period are shown in Figures 3 and 4 (note the different scales used). The rates for all of the top five serovars declined over the 10-year period, with the exception of S. Heidelberg which increased since 2000 (Figure 3). The fluctuation in S. Enteritidis numbers over this period was mainly due to several large outbreaks, including one related to a pre-packaged lunch product in 1998 and another to raw almonds in 2000 and 2001[2-6]. In Figure 4, the prominent peak noted for S. Newport in 1996 was due to a large outbreak associated with alfalfa sprouts[7].

**Figure 2: Reported rates of non-typhoid *Salmonella* cases (per 100,000 population), 1995 to 2004***



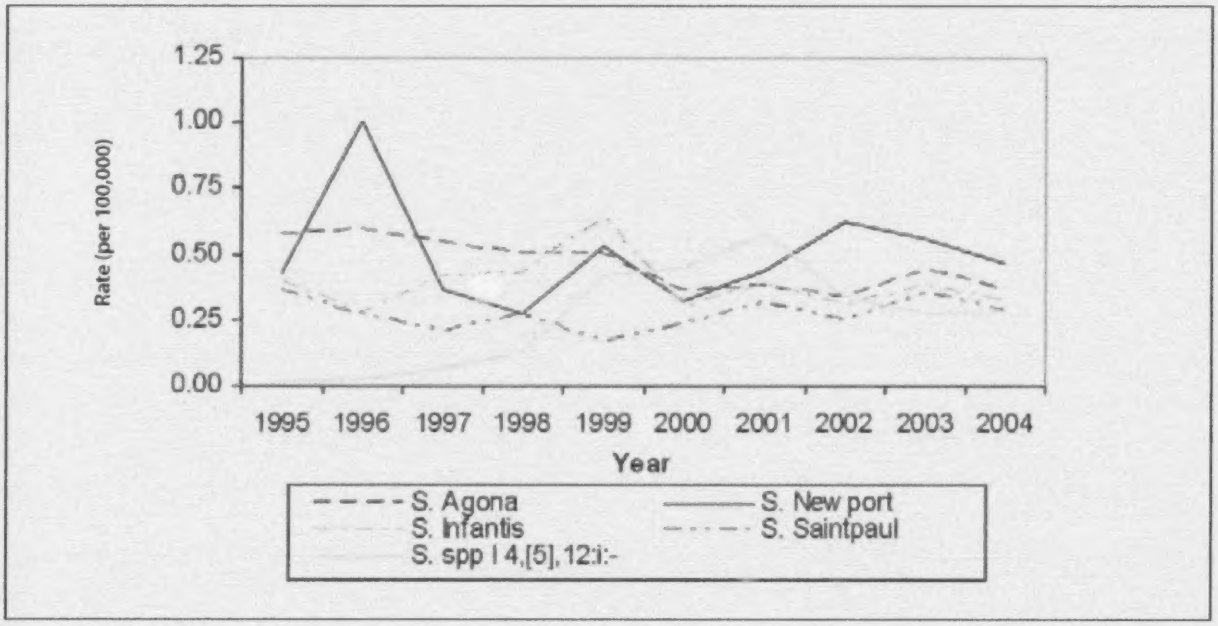

* NML/NESP data includes totals from the NML (1995-1997) and NESP (1998-2004).

**Figure 3: Reported rates of *S.* Typhimurium, *S.* Heidelberg, *S.* Thompson, *S.* Enteritidis and *S.* Hadar infections (per 100,000 population), 1995 to 2004***



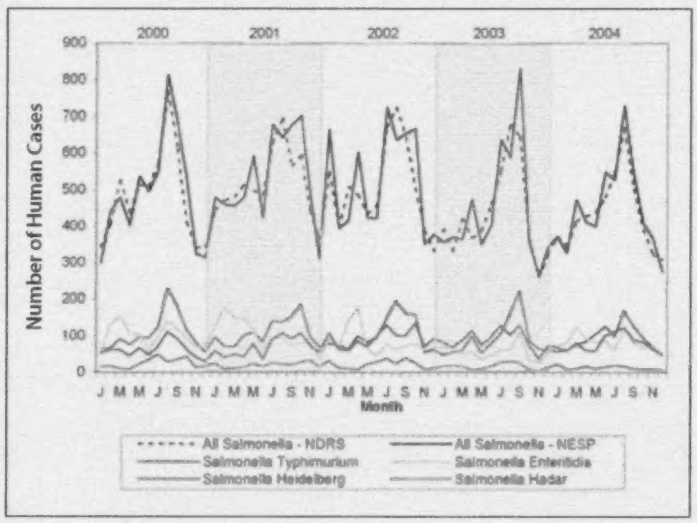

* Data includes totals from the NML (1995-1997) and the NESP (1998-2004) databases.

**Figure 4: Reported rates of *S.* Agona, *S.* Saintpaul, *S.* ssp I 4,[5],12:i:-, *S.* Newport and *S.* Infantis infections (per 100,000 population), 1995 to 2004***




* NML/NESP data includes totals from the NML (1995-1997) and NESP (1998-2004).

**Figure 5: Reported cases of non-typhoid *Salmonella* by month, 2000 to 2004, NDRS and NESP**




## *Monthly and Provincial/ Territorial Trends*

Distinct seasonal trends can be seen when the overall number of non-typhoid *Salmonella* cases are plotted by month, with similar patterns being observed in both NDRS and NESP (Figure 5). Consistent peaks were noted from July through October with smaller peaks in March and April.

Several other distinct peaks throughout the winter and spring months, in particular in 2001 and 2002, reflect some of the larger outbreaks that occurred during this time frame. In the winter of 2001, several outbreaks of S. Enteritidis occurred, including a multi-provincial outbreak associated with raw almonds,

and a smaller outbreak associated with mung bean sprouts[5,6,8]. The winter peak in 2002 was likely influenced by a multi-provincial outbreak of S. Oranienburg.

S. Typhimurium and S. Enteritidis both showed strong seasonal trends, with S. Typhimurium peaking in the summer months and S. Enteritidis peaking in the winter (except for 2003). The winter and early spring peaks in S. Enteritidis infections are likely due to travel-acquired infections[9,10,11].

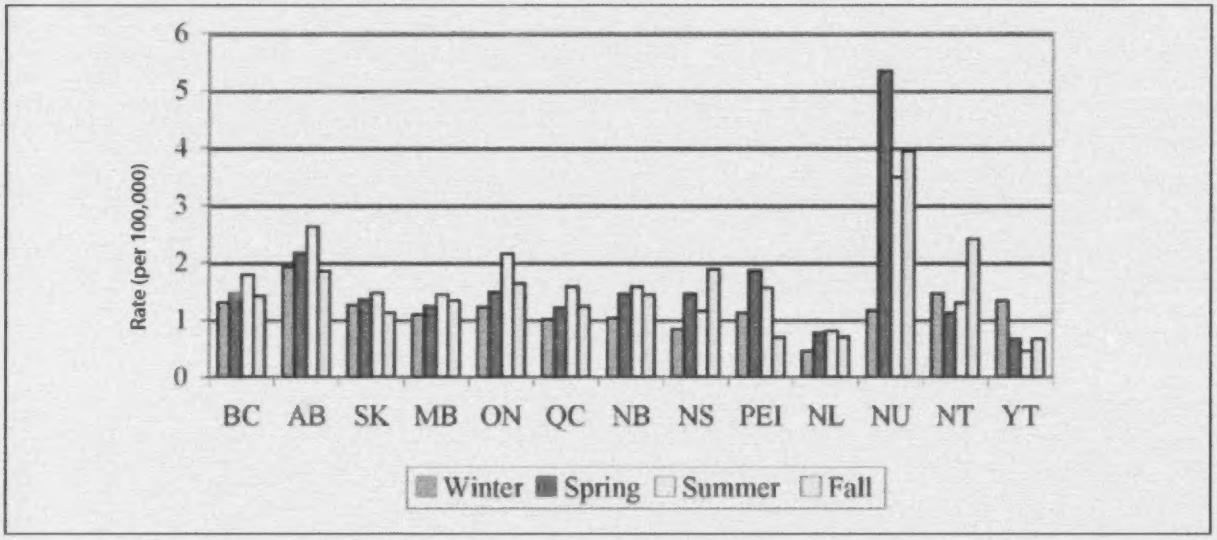
The seasonal trends associated with non-typhoid *Salmonella* infections are similar for most of the provinces and territories (Figure 6). Exceptions to the general trend of a winter low and summer peak can be noted for Nova Scotia, Prince Edward Island, and the Territories. In Nova Scotia, trends were affected by three prominent outbreaks that occurred in the fall of 2000, 2001 and 2003.

The distinct peaks in Figure 6 and 7 in the territories are, at least partially, an artefact of the small population base. The spring, summer and fall peak in Nunavut can also be explained by community clusters of S. Typhimurium in 2002 and 2003 and a national outbreak of S. Oranienburg in 2002.

The fall peak in the Northwest Territories was influenced by several cases of S. Lomalinda and S. Heidelberg connected to two separate events in 2000 and 2001.

Figures 7 to 10 show the annual rate in each province/territory from 2000 to 2004 for the four most common human non-typhoid *Salmonella* serovars (note the different scales used). Considerable variations within and among provinces/territories can be noted for all serovars, in particular S. Enteritidis and S. Hadar. The higher rates noted for territories, likely reflect the small population base.

**Figure 6: Average reported rate of non-typhoid *Salmonella* cases (per 100,000 population per season*), by province/territory, 2000 to 2004, NDRS**




* Winter includes December, January and February; Spring includes March, April and May; Summer includes June, July and August; Fall includes September, October and November.

**Figure 7: Reported rate of *S.* Typhimurium infections (per 100,000 population) by province/territory, 2000 to 2004, NESP**

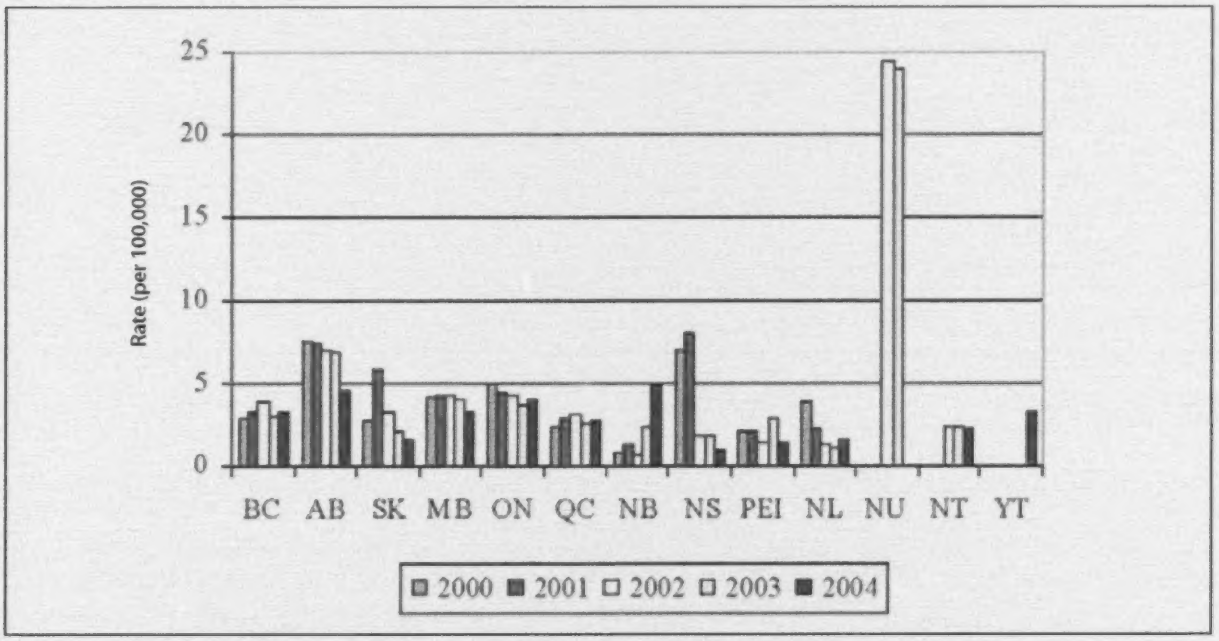



**Figure 8: Reported rate of *S.* Enteritidis infections (per 100,000 population) by province/territory, 2000 to 2004, NESP**

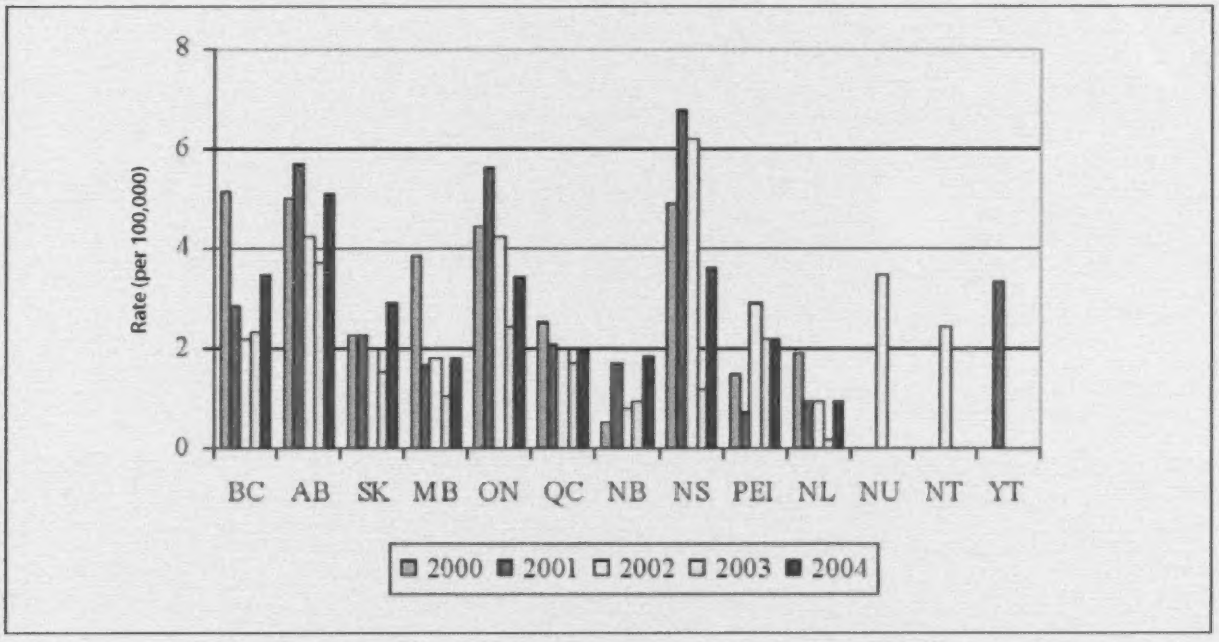


**Figure 9: Reported rate of *S.* Heidelberg infections (per 100,000 population) by province/territory, 2000 to 2004, NESP**

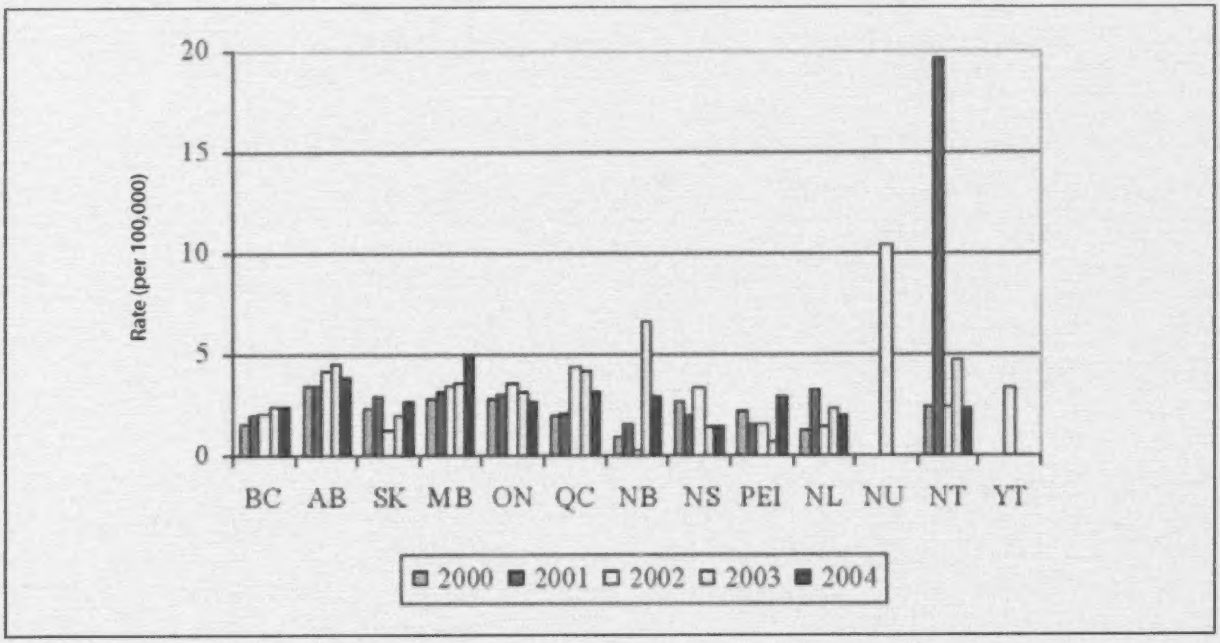
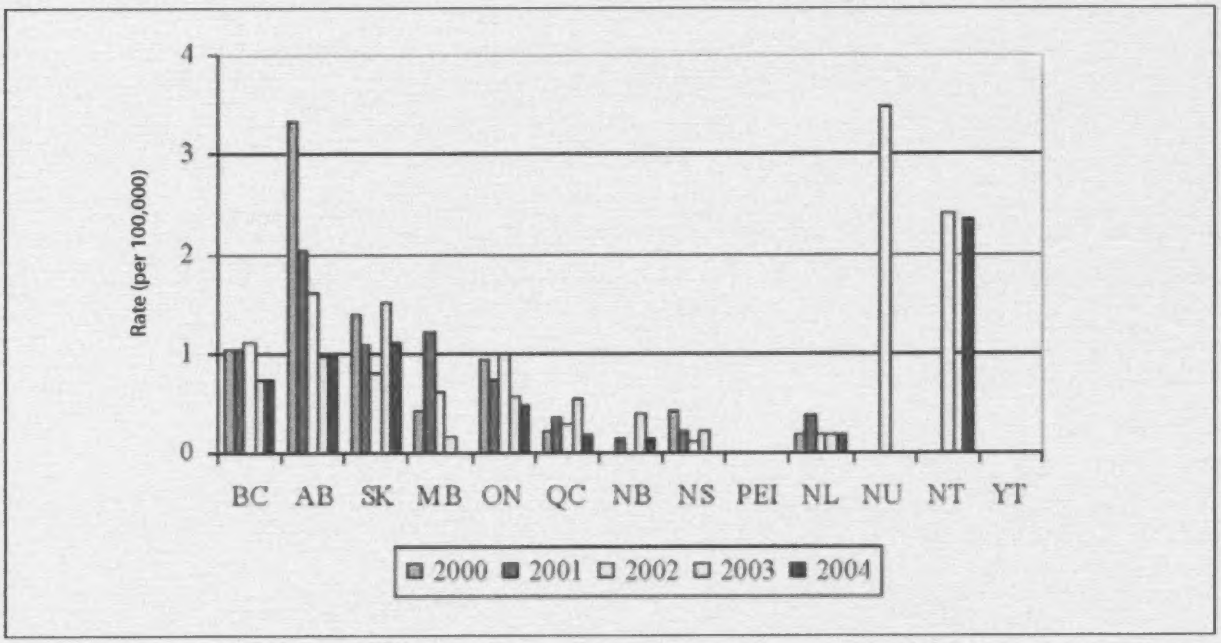


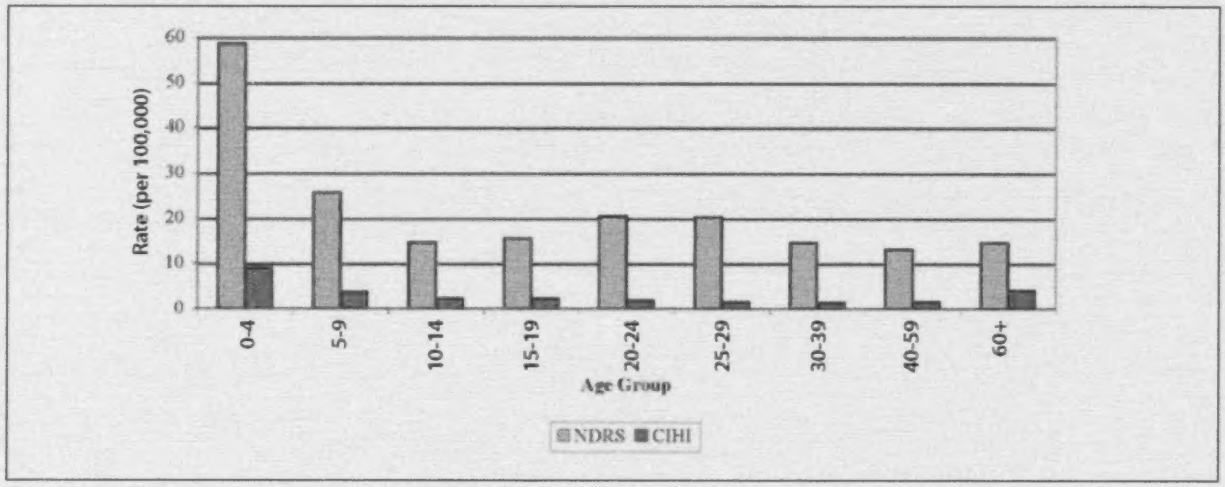

**Figure 10: Reported rate of *S.* Hadar infections (per 100,000 population) by province/territory, 2000 to 2004, NESP**



## Age and Gender Distribution

Infants and young children have the highest reported rate of *Salmonella* infection (NDRS) (Figure 11). A second peak can be seen in ages 20-29. Higher reported rates in this age group may reflect their increased likelihood of engaging in risky eating behaviours than other age groups[12]. The age distribution of hospitalized cases (Figure 11) shows rates which are highest in young children and the elderly, suggesting greater susceptibility to more severe infection in these groups. The rate of *Salmonella* infection was similar for males and females over the five-year period.

**Figure 11: Reported rate of *Salmonella* cases and hospitalizations (per 100,000 population) by age group, 2000 to 2004 combined, NDRS and CIHI**




## Outbreaks, Case Clusters and Exposure Settings

There were 226 outbreaks and case clusters related to *Salmonella* and 2240 outbreak-related laboratory-confirmed cases reported to the NML and NESP between 2000 and 2004. According to the NML/NESP, *Salmonella* outbreaks and case clusters accounted for the largest proportion of reported outbreaks and case clusters and the largest number of outbreak-related cases over the five-year period compared to *E. coli*, *Campylobacter*, and *Shigella*.

The *Salmonella* serovars responsible for outbreaks and case clusters with 10 or more cases, as reported to the NML, NESP and PulseNet Canada, from 2000 to 2004, are listed in Table 4 (for description of outbreak and case cluster data, please refer to Appendix A – Section 3).

Three serovars, *S.* Typhimirum (55), *S.* Enteritidis (41) and *S.* Heidleberg (34) were reported in over half of the 226 outbreaks and case clusters reported during the five year period. This reflects their predo-

minance as the most frequently reported serovars in each year from 2000 to 2004. Although S. Typhimurium accounted for the largest number of reported *Salmonella* outbreaks and case clusters over the five-year period, those associated with S. Enteritidis resulted in higher outbreak-related case counts.

*Salmonella*-related outbreaks and case clusters listed by exposure setting are shown in Table 5. This information was collected through various sources and precise details regarding the settings of these events may be incomplete. A description of the setting categories can be found in Appendix A – Section 3. Household settings represented the largest number of reported *Salmonella* outbreaks and case clusters, while community settings resulted in higher related case counts. In 2002, a travel-related outbreak of S. Typhimurium PT 2 occurred among passengers and crew of a cruise ship travelling from Vancouver to Alaska.

**Table 4: Number of *Salmonella*-related outbreaks and case clusters (and associated laboratory-confirmed cases reported) by serovar, 2000 to 2004, NML, NESP, and PulseNet Canada**

| Serovar | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| S. Agona | - | 1 (14) | - | 1 (2) | 1 (5) |
| S. Anatum | - | - | 1 (20) | - | - |
| S. Berta | - | - | - | 1 (15) | - |
| S. Blockley | - | 1 (15) | - | - | - |
| S. Brandenburg | 1 (14) | - | 1 (18) | - | - |
| S. Enteritidis | 14 (161) | 9 (362) | 6 (20) | 4 (21) | 8 (63) |
| S. Hadar | 5 (31) | 1 (6) | 1 (2) | - | 1 (2) |
| S. Hartford | 1 (3) | - | - | 1 (16) | - |
| S. Heidelberg | 8 (19) | 9 (31) | 5 (19) | 4 (28) | 8 (97) |
| S. Infantis | 1 (2) | 1 (10) | 1 (2) | - | 1 (2) |
| S. Javiana | 2 (10) | - | - | - | 1 (7) |
| S. Minnesota | - | - | - | 1 (17) | - |
| S. Muenster | - | 1 (25) | - | - | - |
| S. Newport | - | - | 3 (34) | 2 (7) | 3 (20) |
| S. Oranienburg | - | - | 1 (189) | 1 (40) | 1 (2) |
| S. Poona | - | - | 1 (10) | - | - |
| S. Stanley | - | 1 (51) | 1 (2) | - | 1 (2) |
| S. Thompson | 5 (55) | 3 (33) | 5 (39) | 2 (20) | 3 (24) |
| S. Typhimurium | 9 (65) | 16 (124) | 7 (64)* | 10 (92) | 13 (100) |
| S. Uganda | - | 1 (20) | - | - | - |
| S. ssp. 1 4,[5],12:b:- | - | - | 2 (11) | 1 (27) | - |
| S. ssp. 1 4,[5],12:i:- | 2 (4) | 4 (61) | 2 (9) | 2 (4) | - |
| Other serovars | 8 (22) | 5 (13) | 1 (2) | 2 (11) | 6 (24) |
| **Total** | **56 (386)** | **53 (765)** | **38 (441)** | **32 (300)** | **47 (348)** |

* Includes 32 cases of S. Typhimurium acquired on a cruise ship sailing out of Vancouver in 2002. Clusters of infections acquired during foreign travel are otherwise not included.

**Table 5: *Salmonella*-related outbreaks and case clusters (number of related cases reported) by exposure settings, 2000 to 2004, NML, NESP and PulseNet Canada**

| Setting | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| Community | 7 (127) | 21 (486) | 14 (291) | 7 (85) | 14 (99) |
| Event/Function | 4 (30) | 1 (14) | 3 (48) | 5 (70) | 1 (9) |
| Food Service | 5 (126) | 4 (167) | 3 (22) | 7 (99) | 10 (154) |
| Household | 36 (77) | 24 (56) | 17 (48) | 9 (21) | 19 (51) |
| Institution-R* | 3 (20) | - | - | 4 (25) | 2 (29) |
| Institution-NR* | 1 (6) | 3 (42) | - | - | 1 (6) |
| Travel | - | - | 1 (32) | - | - |
| **Total** | **56 (386)** | **53 (765)** | **38 (441)** | **32 (300)** | **47 (348)** |

* R - residential and NR - non-residential.

## *Travel-acquired Infections*

Between 2000 and 2004, 286 travel-acquired cases of non-typhoid *Salmonella* were reported to the NESP. Although foreign travel is one of the main risk factors for gastrointestinal illness, case definitions for travel-associated enteric disease are not standardized across Canada and information is rarely captured or reported. Therefore, travel-acquired infections are greatly under-represented in the NESP. A history of travel was provided for approximately 1% of all non-typhoid *Salmonella* infections. Travel to Mexico and the Caribbean accounted for a little more than half of these infections (Table 6).

**Table 6: Number of travel-acquired non-typhoid *Salmonella* infections and associated region/continent/country, 2000 to 2004, NESP**

| Region/Continent/Country | 2000 | 2001 | 2002 | 2003 | 2004 | Total # Per Region |
|---|---|---|---|---|---|---|
| Africa | 3 | 3 | 3 | 7 | 2 | **18** |
| Asia | 7 | 8 | 21 | 7 | 16 | **59** |
| Australia & Pacific | - | - | 2 | - | - | **2** |
| Central & South America | 1 | - | 9 | 3 | 1 | **14** |
| Europe | 12 | 2 | 2 | 2 | 9 | **27** |
| Mexico & Caribbean | 18 | 14 | 43 | 33 | 42 | **149** |
| United States | 1 | 1 | 4 | 2 | 3 | **11** |
| Multiple Regions | - | 3 | 2 | - | - | **5** |
| **Total** | **42** | **31** | **86** | **54** | **73** | **286** |

# *S.* Typhi and *S.* Paratyphi Cases

The number of S. Typhi and S. Paratyphi (including S. Paratyphi A, B and C) infections reported from 2000 to 2004 are shown in Table 7. An increase in cases was observed for both serovars over the five-year period. Since S. Typhi and S. Paratyphi are not endemic in Canada, this increase reflects travel to endemic countries by Canadians[9,13]. Paratyphoid fever (S. Paratyphi infections) was removed from the national notifiable disease list in 1999, consequently, there can be no data comparison with the NESP data from 2000 onward.

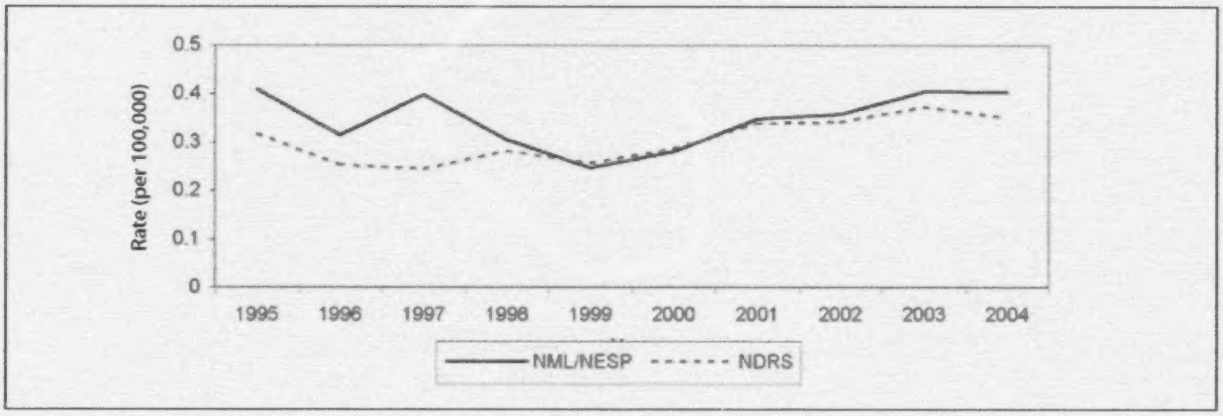
The national rate of S. Typhi infections from 1995 to 2004 remained stable except for a sharp decrease from 1997 to 1999 (Figure 12). The number of S. Typhi cases recorded in the NESP database was slightly higher than in the NDRS database.

**Table 7: Cases of *S.* Paratyphi and *S.* Typhi, 2000 to 2004, NESP and NDRS**

| | | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|
| S. Paratyphi* | *NESP* | 76 | 107 | 135 | 123 | 140 |
| | *NDRS* | - | - | - | - | - |
| S. Typhi | *NESP* | 86 | 108 | 112 | 128 | 129 |
| | *NDRS* | 88 | 105 | 101 | 113 | 115 |

* Includes S. Paratyphi A, Paratyphi B & B var. Java & Paratyphi C (1 case in QC in 2001 only).

**Figure 12: Reported rates of *S.* Typhi cases (per 100,000 population), 1995 to 2004***

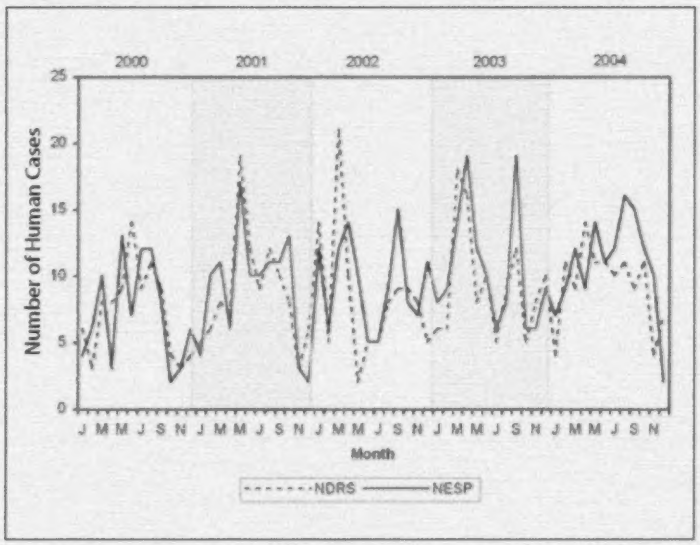



NML/NESP data includes totals from the NML (1995-1997) and NESP (1998-2004).

The seasonal trend of reported cases of S. Typhi from 2000 to 2004 shows distinct peaks throughout the spring and early fall seasons (Figure 13).

Although S. Typhi totals increased in both the NESP and NDRS databases throughout this period, there was considerable variation in provincial totals between the two databases.

**Figure 13: Reported rates of *S.* Typhi by month, 2000 to 2004, NDRS and NESP**




Figures 14 and 15 show the annual rate in each province and territory for *S.* Typhi and *S.* Paratyphi from 2000 to 2004. There is considerable variation within and among provinces/territories, with the highest rates occurring in British Columbia. An increase in *S.* Typhi isolations in British Columbia in early 2003 led to an investigation which confirmed that many of these infections were linked to travel to the state of Punjab, India. The overall increase of *S.* Paratyphi was due to increased number of cases reported in Ontario and British Columbia (Figure 15). Prince Edward Island reported one case of *S.* Typhi and three *S.* Paratyphi over the five year period, which resulted in high provincial rates of infection due to the small population size. No cases of *S.* Typhi and *S.* Paratyphi were reported for the territories.

**Figure 14: Reported rate of *S.* Typhi infections (per 100,000 population) by province/territory, 2000 to 2004, NESP**

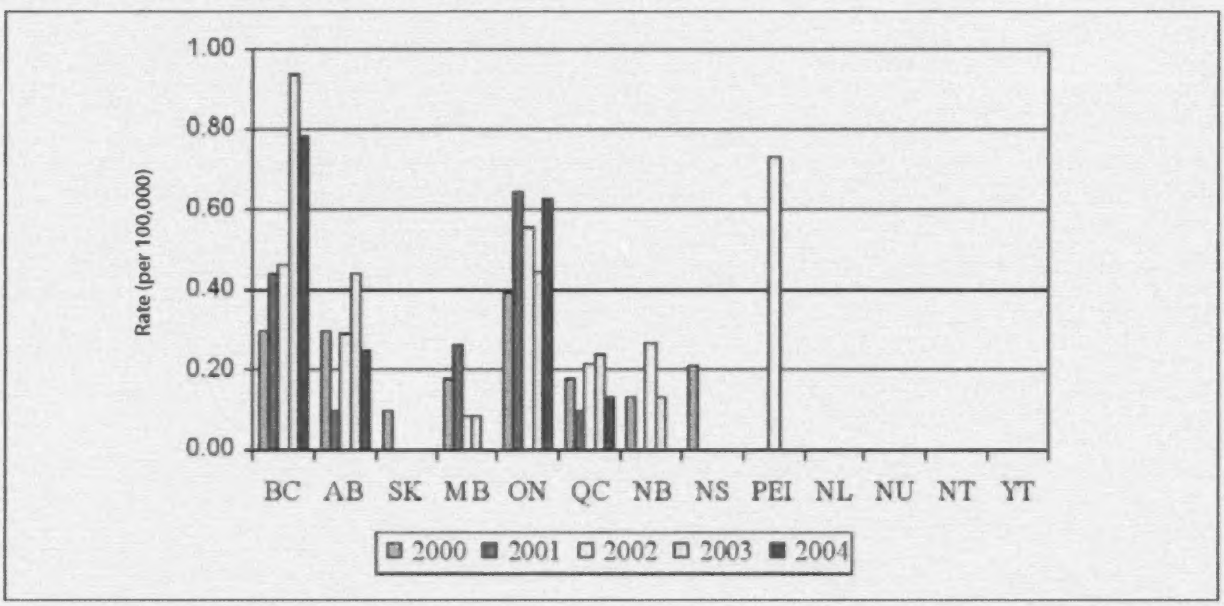
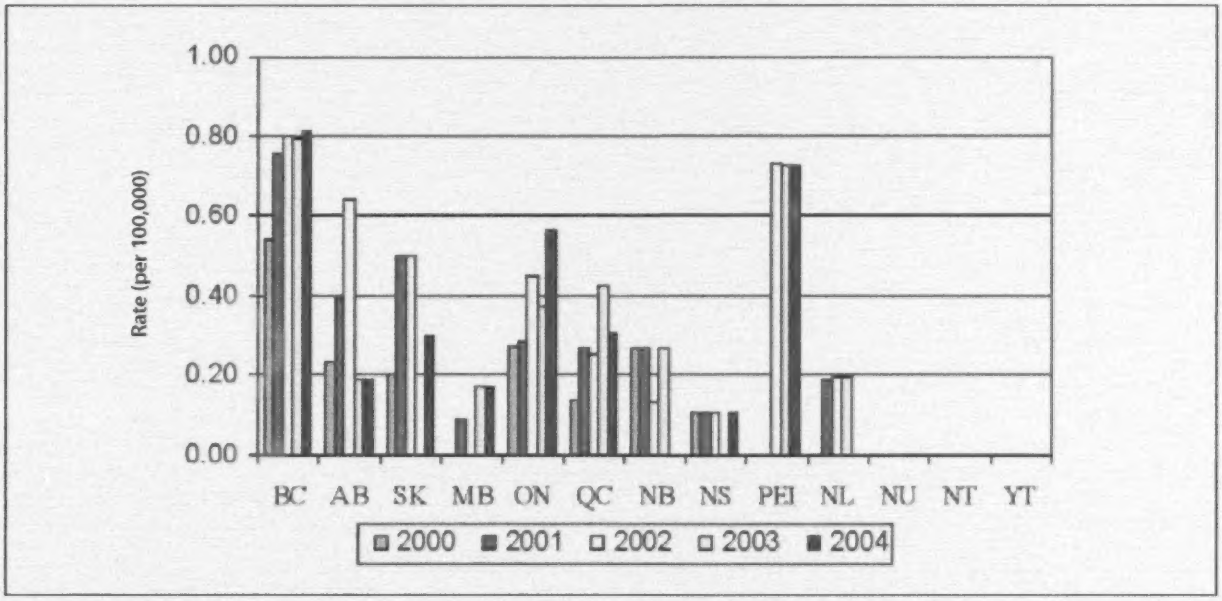


**Figure 15: Reported rate of *S.* Paratyphi infections (per 100,000 population) by province/territory, 2000 to 2004, NESP**




A history of travel was provided for 47 cases of *S.* Typhi and *S.* Paratyphi reported to the NESP from 2000 to 2004. During this period, only 25 of the 563 *S.* Typhi, and 22 of the total 581 *S.* Paratyphi cases reported were identified as travel-related, although the majority of these were likely related to foreign travel since *S.* Typhi and *S.* Paratyphi are not endemic in Canada. Travel to Asia accounted for 96% (45/47) of all *S.* Typhi and *S.* Paratyphi cases for which history of travel was provided to the NESP (Table 8). Approximately 56% (291/519) of typhoid fever (*S.* Typhi) cases reported to the NDRS were identified as travel-related with travel to Asia, Africa, Central America and South America being reported.

**Table 8: Number of travel-acquired *S.* Paratyphi and *S.* Typhi infections and associated continents, 2000 to 2004, NESP**

| Region/Continent/Country | 2000 | 2001 | 2002 | 2003 | 2004 | Total # Per Region |
|---|---|---|---|---|---|---|
| ***S.* Paratyphi** | | | | | | |
| Asia | 1 | 1 | 10 | 3 | 7 | **22** |
| ***S.* Typhi** | | | | | | |
| Africa | 1 | - | - | - | - | **1** |
| Asia | 1 | 4 | 7 | 5 | 6 | **23** |
| Unknown | - | - | - | 1 | - | **1** |
| **Total** | **3** | **5** | **17** | **9** | **13** | **47** |

# Antimicrobial Resistance Trends in Human *Salmonella* Infections

The *'Surveillance of Human Clinical Isolates'* component of CIPARS, is designed to provide representative data on human *Salmonella* isolates at the provincial level (See Appendix A – Section 4). A series of studies was initially conducted to support the development of a national antimicrobial resistance surveillance program for enteric pathogens. Between 1997 and 2000, although the differing laboratory methods for bacterial isolation and testing antimicrobial susceptibility may have resulted in biased estimates, there was an indication that resistance could be increasing among certain serovars of *Salmonella*, particularly for drugs of Very High Importance and High Importance in Human Medicine (Category I and II)[14]. In 2003 and 2004, a representative sample of 3056 and 3147 clinical *Salmonella* isolates were collected from all provincial public health laboratories, respectively. An increase in prevalence of resistance to one or more of 16 antimicrobials tested was observed among S. Heidelberg, S. Typhi, and S. Enteritidis isolates in 2004, compared to the previous year (Table 9). Resistance to ceftiofur increased slightly from 6% of all isolates in 2003 to 7% in 2004[17,18]. Although resistance to ceftriaxone remained low, its reduced susceptibility in S. Heidelberg isolates (including blood isolates) was of concern, having increased from 8% of isolates in 2003, to 26% in 2004[15,16].

**Table 9: Prevalence of resistance to one or more of the 16 antimicrobials tested, 2003 and 2004, CIPARS**

| Year | *S.* Typhimurium | *S.* Typhi | *S.* Heidelberg | *S.* Enteritidis | *S.* Newport |
|---|---|---|---|---|---|
| 2003 | 52% | 50% | 46% | 22% | 16% |
| 2004 | 47% | 58% | 56% | 29% | 14% |

## *Selected Phage Types*

The number of human isolates of the top four *Salmonella* serovars that were forwarded to the National Microbiology Laboratory (NML) as part of reference requests, active and passive surveillance, surveys or outbreak and cluster investigations are presented in Table 10. All isolates of these top four serovars, as well as all S. ssp I 4,[5],12:b:-, S. Infantis, S. Newport, S. Oranienburg, S. Panama, S. Thompson and S. Typhi isolates are phage typed, consequently, the total counts in this table indicate the total number of isolates forwarded to the NML. Although *Salmonella* isolates are sent to the NML as part of CIPARS, submission of non-CIPARS *Salmonella* isolates can occur and be influenced by enhanced surveillance and outbreak investigations.

The most prevalent phage types among the top four *Salmonella* serovars from human isolates are shown in Figures 16 to 19. S. Typhimurium PT 104, S. Enteritidis PT 4, and S. Heidelberg PT 19 were the most common phage types identified over the five-year period. Between 2000 and 2004, the proportion of S. Typhimurium PT 104 decreased; S. Enteritidis PT 13 increased; S. Heidelberg PT 19 decreased while PT 29 increased; and S. Hadar PT 47 decreased. The increase in S. Heidelberg PT 29 was observed at the same time as an increase in multi-drug resistance in this strain[16].

**Table 10: Number of human isolates in the top four *Salmonella* serovars that were phage typed, 2000 to 2004, NML**

| Serovar | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| *S.* Typhimurium | 1246 | 835 | 731 | 912 | 790 |
| *S.* Enteritidis | 955 | 1275 | 973 | 636 | 927 |
| *S.* Heidelberg | 230 | 463 | 1050 | 1063 | 917 |
| *S.* Hadar | 108 | 77 | 65 | 118 | 110 |

Note: All isolates sent to the NML that were phage typed.

**Figure 16: Proportion of the top *S.* Typhimurium phage types from human isolates, 2000 to 2004, NML**

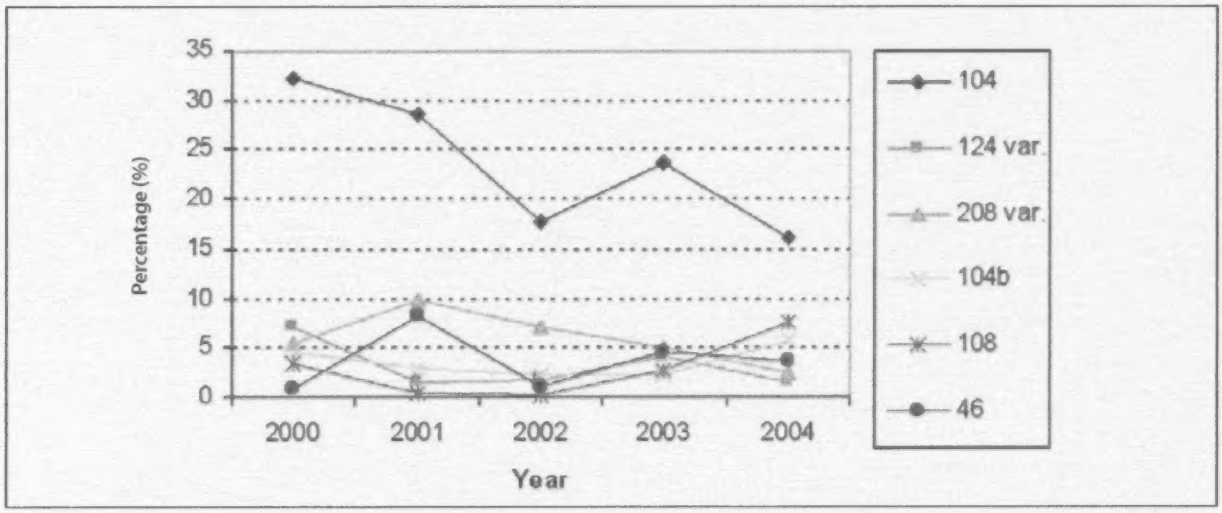



**Figure 17: Proportion of the top *S.* Enteritidis phage types from human isolates, 2000 to 2004, NML**

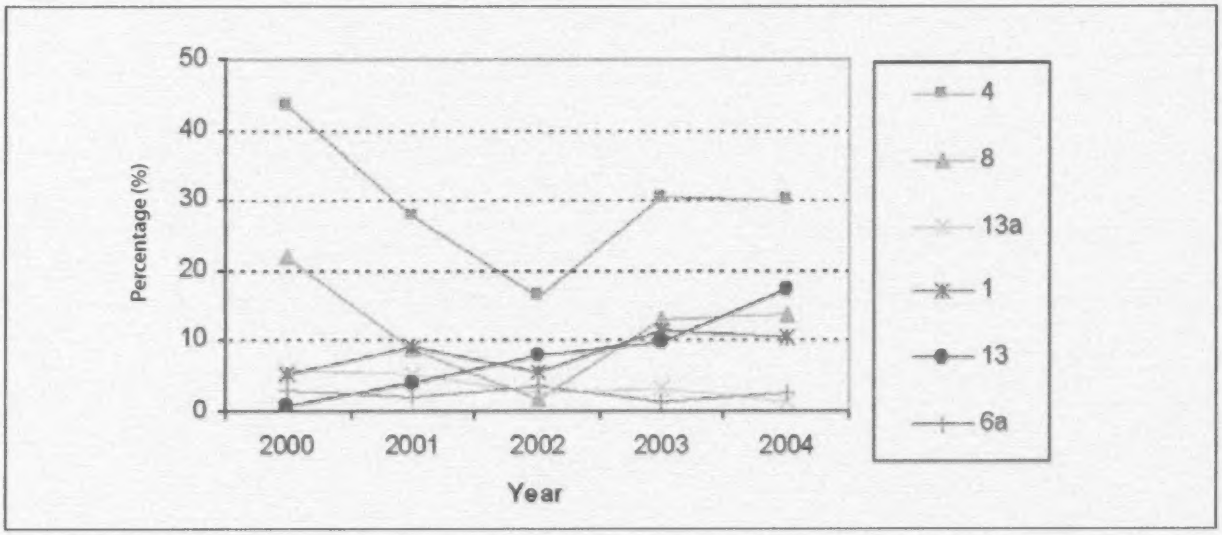


**Figure 18: Proportion of the top *S.* Heidelberg phage types from human isolates, 2000 to 2004, NML**

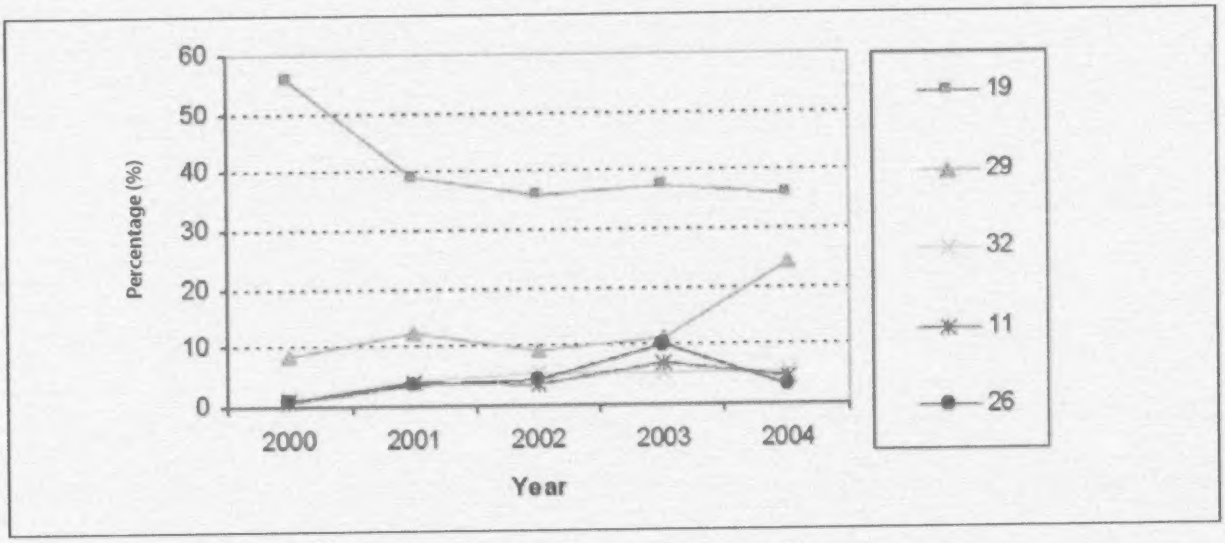
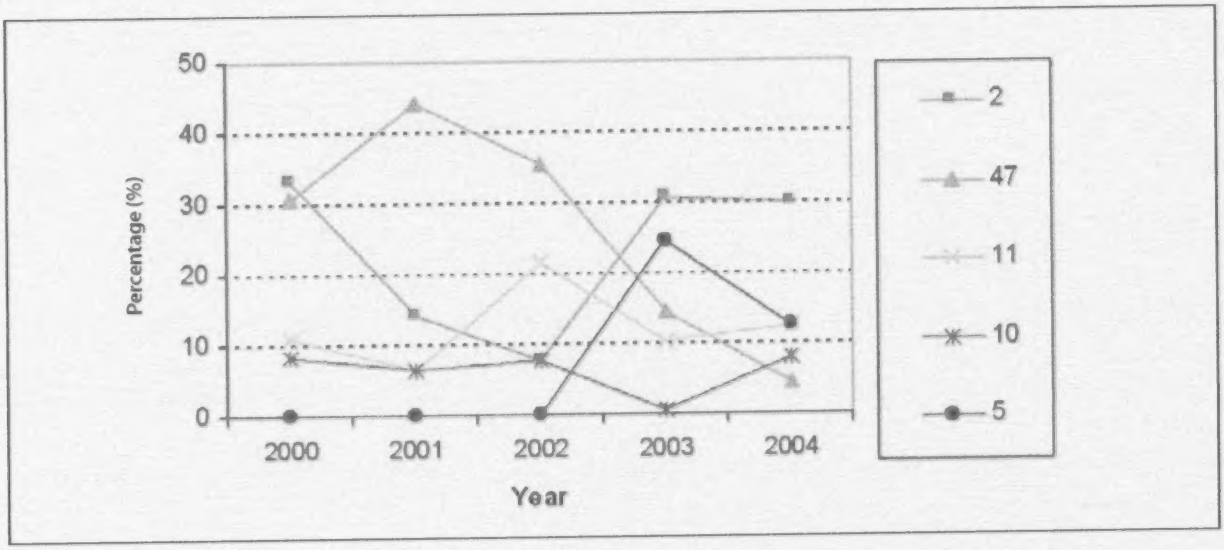



**Figure 19: Proportion of the top *S.* Hadar phage types from human isolates, 2000 to 2004, NML**



# *Salmonella* Isolates from Non-human Sources

There were 1971, 2050, 2009, 2415 and 1668 *Salmonella* isolates from non-human sources sent to the LFZ from 2000 to 2004, respectively (these numbers excluded quality assurance and research isolates) (See Appendix A – Section 5). The number of isolates by province and year is shown in Table 11. Isolates with unknown province of origin were excluded from the analysis. Non-human isolates from the CIPARS abattoir and retail components are included in the total *Salmonella* isolate counts reported by the LFZ in 2002 (abattoir), 2003 and 2004. For more detailed CIPARS information, please refer to the CIPARS website and reports (http://www.phac-aspc.gc.ca/cipars-picra/index_e.html). The absence of an appropriate denominator does not allow for a calculation of rates, therefore the following analysis includes only total counts.

Isolates sent to the LFZ for passive surveillance of diagnostic isolates or for government or industry monitoring are not necessarily provincially representative. The number of submissions can vary by place and time, therefore the data should be interpreted with caution. The abattoir component of CIPARS however, is more representative and stable over time. The non-human data should not be considered an indication of magnitude. However, the data can be useful to establish general trends, recognize emerging or re-emerging serovars and provide an overview of the various serovars identified from non-human sources.

**Table 11: Number of non-human *Salmonella* isolates by province, 2000 to 2004, LFZ***

| | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| NL | 45 | 13 | 29 | 37 | 24 |
| PEI | 27 | 13 | 20 | 12 | 16 |
| NS | 51 | 47 | 49 | 54 | 33 |
| NB | 33 | 36 | 42 | 50 | 16 |
| QC | 188 | 207 | 197 | 347 | 494 |
| ON | 1405 | 1369 | 1387 | 1463 | 967 |
| MB | 63 | 76 | 61 | 124 | 34 |
| SK | 15 | 10 | 9 | 45 | 36 |
| AB | 122 | 259 | 205 | 247 | 36 |
| BC | 16 | 16 | 8 | 25 | 9 |

*An additional 26 foreign isolates included samples from imported/visiting animals or food products (2000, 6; 2001, 4; 2002, 2; 2003, 11; 2004, 3).

## Top 10 Serovars

The top 10 *Salmonella* serovars from non-human sources reported by source to the LFZ, between 2000 and 2004, are listed in Table 12. S. Heidelberg was the most frequently reported serovar in chicken and turkey isolates over the five-year period, while S. Typhimurium was most frequently reported in bovine and porcine isolates. At least nine of the top 10 serovars from human cases were represented in the top 10 serovars from non-human sources over the five- year period.

**Table 12: Top 10 *Salmonella* serovars (number) isolated from non-human sources reported, by source, 2000 to 2004 combined, LFZ***

| | BOVINE | CHICKEN | PORCINE | TURKEY |
|---|---|---|---|---|
| 1 | **S. Typhimurium var Copenhagen** (284) | **S. Heidelberg** (1616) | **S. Typhimurium var Copenhagen** (329) | **S. Heidelberg** (563) |
| 2 | **S. Typhimurium** (282) | S. Kentucky (661) | **S. Typhimurium** (272) | S. Senftenberg (127) |
| 3 | S. Kentucky (148) | **S. Typhimurium** (189) | S. Derby (160) | **S. Saintpaul** (78) |
| 4 | S. Muenster (70) | **S. Hadar** (145) | **S. Infantis** (81) | S. ssp I:ROUGH-O:r:1,2 (63) |
| 5 | **S. Newport** (65) | S. ssp I:ROUGH-O:r:1,2 (119) | S. Brandenburg (53) | S. Montevideo (44) |
| 6 | **S. Heidelberg** (30) | **S. Thompson** (118) | **S. Heidelberg** (33) | **S. Agona** (41) |
| 7 | **S. Thompson** (28) | S. Brandenburg (101) | **S. Agona** (27) | **S. Newport** (35) |
| 8 | S. Montevideo (24) | S. Schwarzengrund (88) | S. Mbandaka (25) | S. Brandenburg (29) |
| 9 | S. ssp I:18:-:- (22) | **S. Enteritidis** (87) | S. London (18) | S. Muenster (29) |
| 10 | S. Cerro (21) | S. Mbandaka (84) | S. Bovismorbificans (17) | S. Bredeney (27) |

* Bold indicates that the serovar was also among the top 10 *Salmonella* serovars isolated from human cases in any of the 5 years (2000 to 2004).

## Serovars Increasing in Frequency

Table 13 lists the *Salmonella* serovars from non-human sources, showing an increase in reporting frequency (by source) in at least four consecutive years from 2000 to 2004.

**Table 13: *Salmonella* serovars from non-human sources, by source, 2000 to 2004, LFZ**

| Serovar | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| BOVINE | | | | | |
| S. ssp I:18:-:- | 1 | 3 | 6 | 9 | 3 |
| S. Mbandaka | 0 | 2 | 4 | 7 | 2 |
| CHICKEN | | | | | |
| S. Agona | 3 | 8 | 10 | 14 | 9 |
| S. Hadar | 24 | 26 | 28 | 48 | 19 |
| S. Kentucky | 89 | 130 | 156 | 160 | 126 |
| S. Mbandaka | 13 | 19 | 22 | 24 | 6 |
| PORCINE | | | | | |
| S. Bovismorbificans | 0 | 1 | 2 | 10 | 4 |
| S. Derby | 7 | 17 | 24 | 70 | 42 |
| S. Schwarzengrund | 0 | 1 | 3 | 6 | 4 |
| S. Senftenberg | 1 | 0 | 2 | 5 | 6 |
| TURKEY | | | | | |
| S. Montevideo | 7 | 5 | 6 | 11 | 15 |
| S. Saintpaul | 1 | 1 | 6 | 19 | 51 |

## Non-human Salmonella Isolate Sources

The sources of non-human isolates of *S.* Typhimurium, *S.* Enteritidis, *S.* Heidelberg and *S.* Hadar are summarized in Figures 20-23 (note the different scales used) (See Appendix A – Section 5). If the "source" was not indicated or did not correspond to one of the listed categories, it was classified as "Other".

*S.* Heidelberg, *S.* Hadar, and *S.* Enteritidis were largely isolated from poultry (e.g. chicken and turkeys), with the majority of isolates coming from environmental or animal sources. A large number of *S.* Typhimurium isolates were also from chicken although bovine and porcine sources remained the major source.

**Figure 20: *S.* Typhimurium isolates from non-human sources, 2000 to 2004**

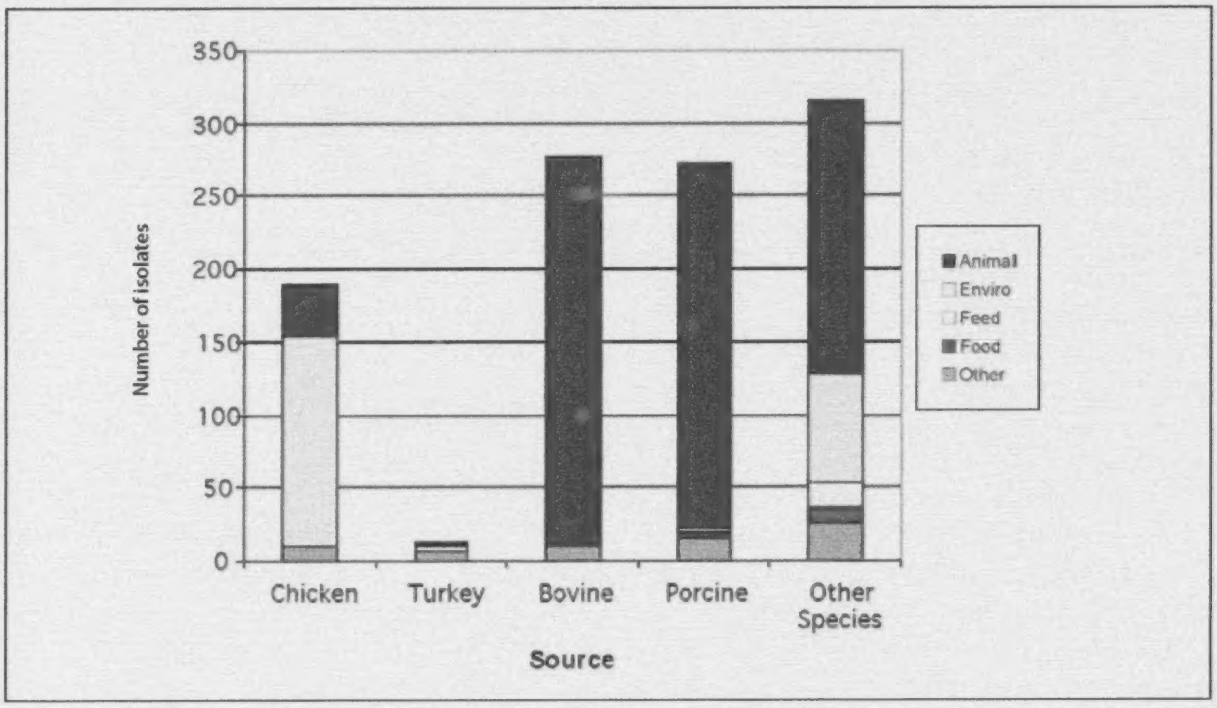


**Figure 21: *S.* Hadar isolates from non-human sources, 2000 to 2004**

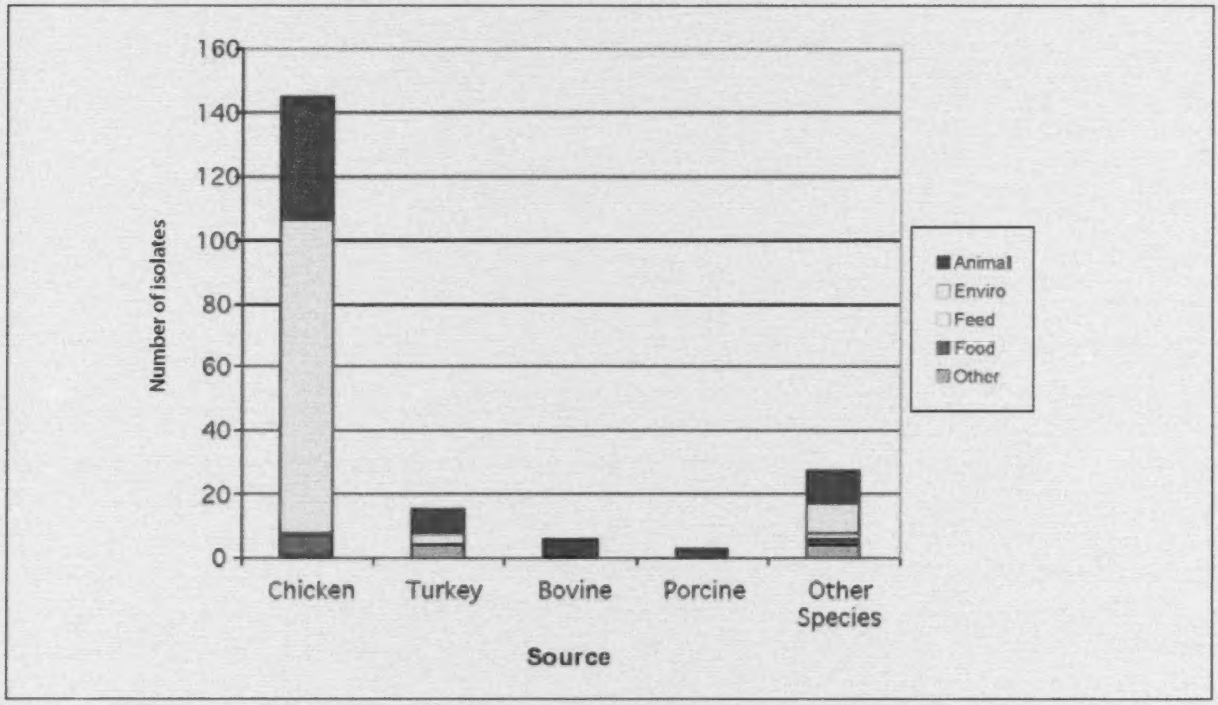



**Figure 22: *S.* Heidelberg isolates from non-human sources, 2000 to 2004**

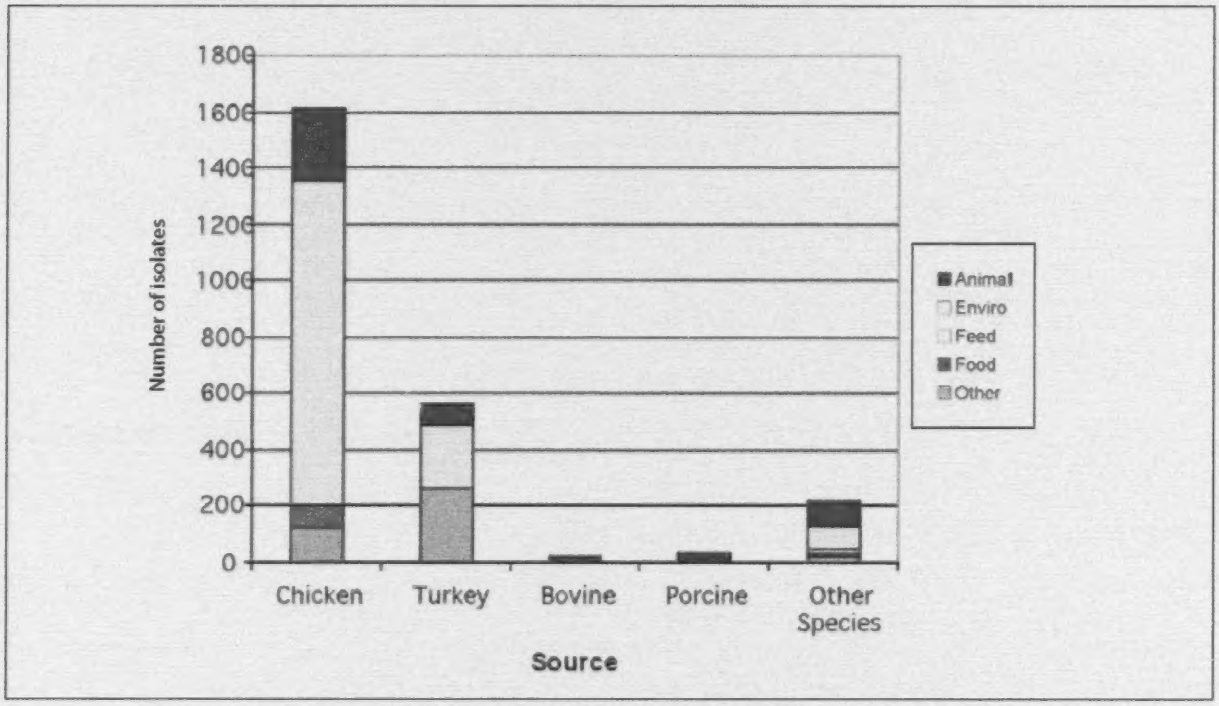
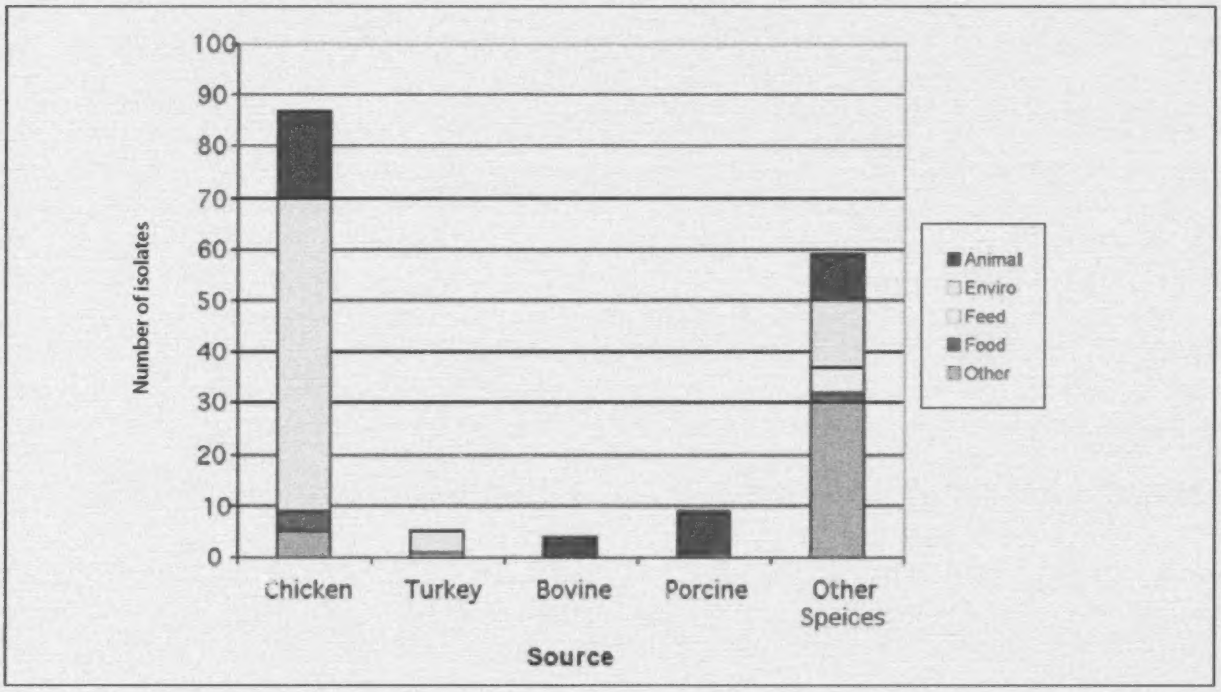


**Figure 23: *S.* Enteritidis isolates from non-human sources, 2000 to 2004**




## *Companion Animals as a Reservoir for Salmonella*

Horses and birds were the most common sources of *Salmonella* isolates from companion animals (Table 14). *S.* Typhimurium was the most frequently identified serovar, making up 34% of all *Salmonella* isolates from companion animals. Companion animal isolates may also have included isolates from animals used for research purposes.

**Table 14: *Salmonella* serovars isolated from companion animals, 2000 to 2004, LFZ**

| Serovar | Birds | Cats | Dogs | Horses | Reptiles | Other Warm-blooded* | Other Cold-blooded | Total |
|---|---|---|---|---|---|---|---|---|
| *S.* Typhimurium | 92 | 15 | 4 | 77 | 3 | 22 | 0 | **213** |
| *S.* Heidelberg | 25 | 0 | 11 | 50 | 0 | 6 | 0 | **92** |
| *S.* Typhimurium var. Copenhagen | 39 | 4 | 4 | 19 | 0 | 11 | 0 | **77** |
| *S.* Mbandaka | 1 | 0 | 1 | 13 | 9 | 1 | 0 | **25** |
| *S.* Enteritidis | 2 | 0 | 0 | 1 | 1 | 11 | 0 | **15** |
| *S.* Thompson | 4 | 0 | 3 | 7 | 0 | 1 | 0 | **15** |
| Other serovars | 35 | 8 | 20 | 49 | 54 | 27 | 3 | **196** |
| **Total** | **198** | **27** | **43** | **216** | **67** | **79** | **3** | **633** |

* Other warm-blooded animals include all other animals that did not correspond to these categories

# Human *Campylobacter* Cases

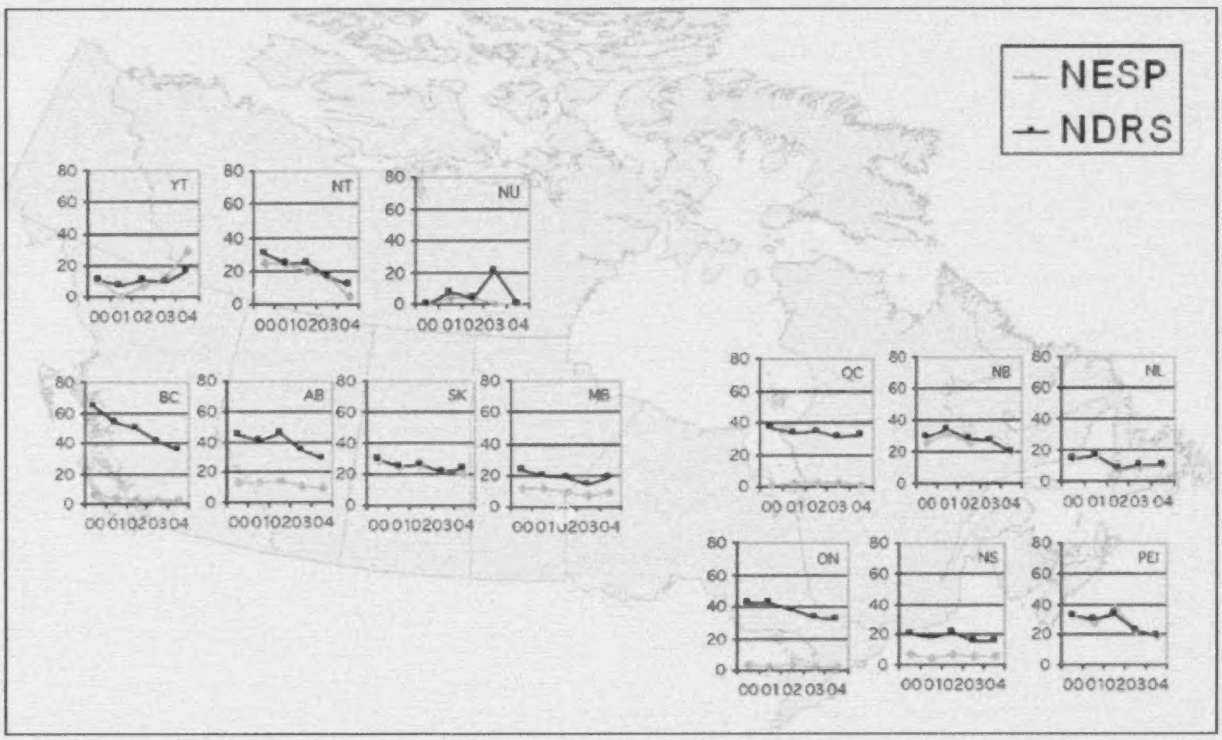
The number of *Campylobacter* cases reported to the NDRS declined between 2000 and 2004 (Table 15). Although *Campylobacter* numbers reported to the NESP were considerably lower over the five-year period, a similar trend was observed in NDRS. The difference between the NDRS and NESP data reflect the low frequency with which *Campylobacter* isolates are sent or reported from local laboratories to the provincial laboratories. NESP assesses *Campylobacter* isolate data under the assumption that the isolate and data flow are consistent over time in each province.

*Campylobacter* rates derived from the NDRS and the NESP databases are shown in Figure 24. The difference between the two databases was most apparent in British Columbia, Ontario, Québec, and Alberta. For all provinces and territories, with the exception of the Yukon and Nunavut, a decline in the rate was observed between 2000 and 2004 according to the NDRS data. The four provinces with the largest populations also had the highest rates, with British Columbia reporting a rate above 60 per 100,000 population in 2000 (NDRS).

**Table 15: Number of campylobacteriosis cases in Canada by year and surveillance system**

| | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| *NDRS* | 12641 | 11886 | 11543 | 10027 | 9600 |
| *NESP* | 1994 | 1718 | 1807 | 1529 | 1305 |

**Figure 24: Rates of campylobacteriosis (per 100,000 population) as reported to the National Notifiable Disease Summary program (NDRS) and the National Enteric Surveillance Program (NESP) by province/territory, 2000 to 2004**



## Campylobacter Species

The number of cases by *Campylobacter* species reported to the NESP is listed in Table 16. The most prevalent species reported between 2000 and 2004 was *C. jejuni*. The ratio of *C. jejuni* to *C. coli* was approximately 6:1.

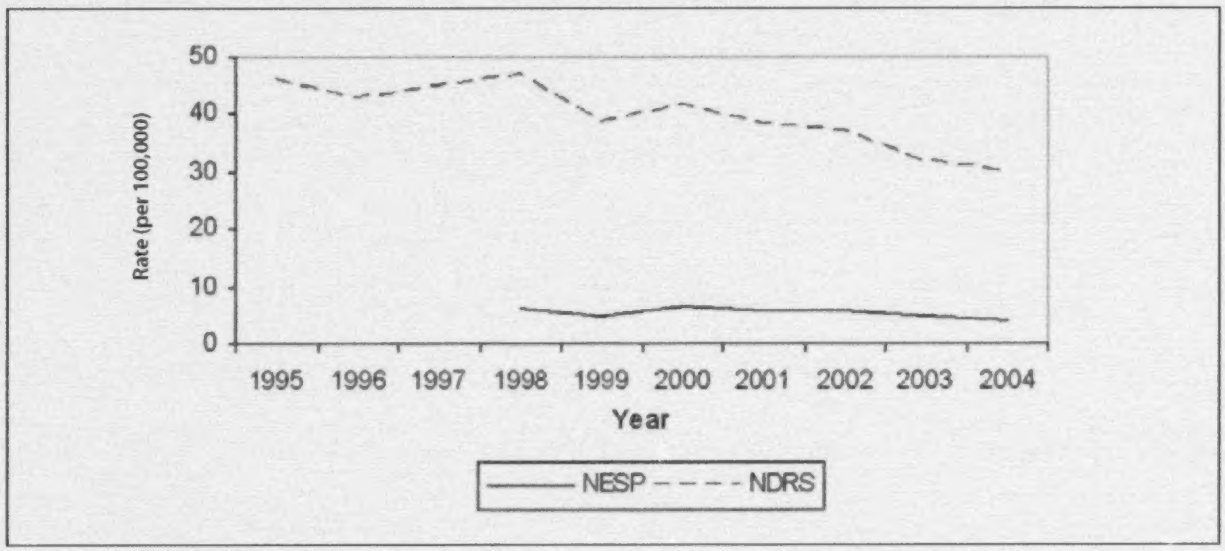
**Table 16: *Campylobacter* species (number), 2000 to 2004, NESP**

| | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| 1 | *C. jejuni/coli* (977) | *C. jejuni* (1194) | *C. jejuni* (1352) | *C. jejuni* (1120) | *C. jejuni* (933) |
| 2 | *C. jejuni* (763) | *C. coli* (197) | *C. coli* (190) | *C. coli* (186) | *C. coli* (189) |
| 3 | *C. coli* (79) | *C. jejuni/coli* (188) | *C. jejuni/coli* (131) | *C. jejuni/coli* (97) | *C. jejuni/coli* (96) |
| 4 | *C. fetus ssp. fetus* (16) | *C. fetus ssp. fetus* (17) | *C. upsaliensis* (38) | *C. lari* (25) | *C. fetus ssp. fetus* (17) |
| 5 | *C. upsaliensis* (11) | *C. upsaliensis* (15) | *C. fetus ssp. fetus* (21) | *C. fetus ssp. fetus* (23) | *C. lari* (12) |
| 6 | *C. lari* (9) | *C. lari* (14) | *C. lari* (19) | *C. upsaliensis* (20) | *C. upsaliensis* (11) |
| 7 | *Other* (1) | *Other* (1) | *Other* (2) | *Other* (2) | *Other* (1) |
| 8 | Not specified (138) | Not specified (92) | Not specified (54) | Not specified (56) | Not specified (46) |

## Long-term Trends

According to the NDRS data, the rate of campylobacteriosis declined between 1995 and 2004 (Figure 25). The rate of *Campylobacter* infections reported to the NESP was relatively constant from 1998 to 2004, leading to a fairly consistent 7-fold difference between the two databases. As noted above, the lower rates recorded by the NESP reflect the low frequency with which *Campylobacter* isolates are sent or reported to most of the provincial laboratories.

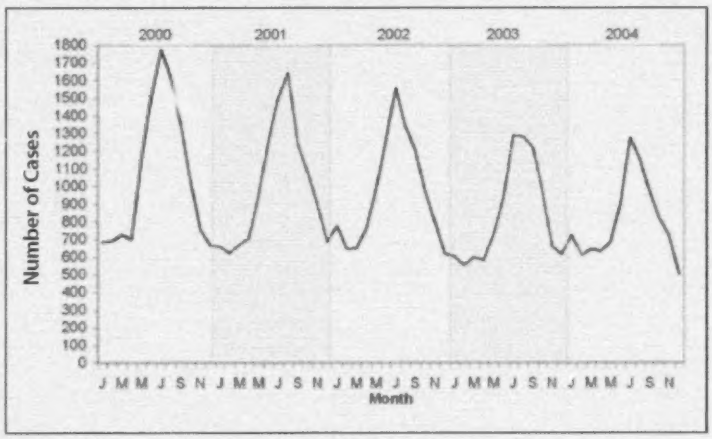
**Figure 25: Rates of *Campylobacter* cases (per 100,000 population), 1995 to 2004, NDRS and NESP**




## Monthly and Provincial/Territorial Trends

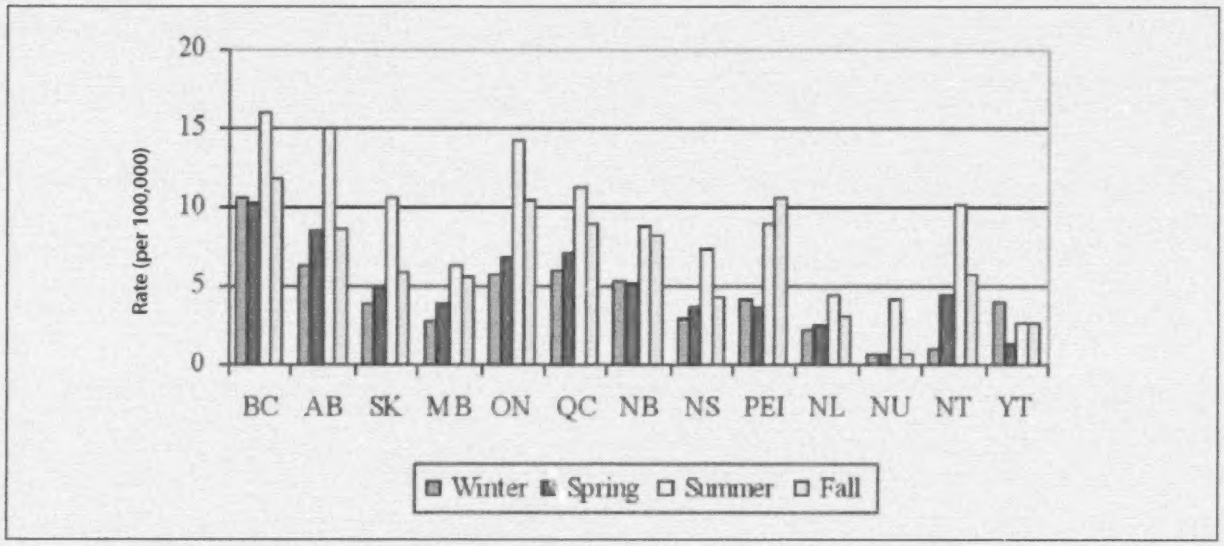
The frequency of *Campylobacter* infections reported through the NDRS by month is shown in Figure 26. Clear and progressively smaller summer peaks were observed between 2000 and 2004. Overall the lowest monthly numbers reported were in February and March. The seasonal variation in *Campylobacter* rates (combined over the five-year period) by province/territory is shown in Figure 27. Similar seasonal patterns were observed for most provinces/territories, with the summer season having the majority of cases reported, except in the Yukon and Prince Edward Island.

**Figure 26: Reported cases of *Campylobacter* by month, 2000 to 2004, NDRS**




Very few outbreaks or case clusters related to *Campylobacter* were recorded during this five-year period. In 2000, 116 *Campylobacter* infections were confirmed among residents of Walkerton, Ontario and were associated with a community-wide outbreak of *E. coli* O157:H7 and *Campylobacter* infections linked to the contaminated municipal water supply[17]. In 2004, 40 cases of *C. coli* infection reported by British Columbia were associated with a deli counter at a grocery store.

**Figure 27: Average reported rate of *Campylobacter* cases (per 100,000 population per season*) by province/ territory, 2000 to 2004, NDRS**

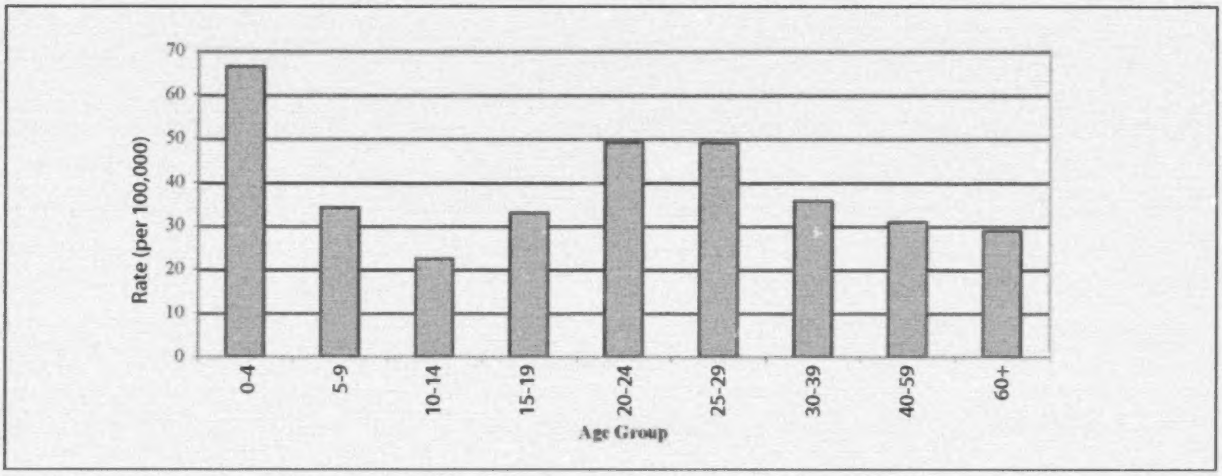



*Winter includes December, January and February; Spring includes March, April and May; Summer includes June, July and August; Fall includes September, October and November.

## Age and Gender Distribution

The rate of *Campylobacter* infection by age group is shown in Figure 28. The highest rate was observed in infants and young children, followed by adults in their 20s.

**Figure 28: Reported rate of *Campylobacter* cases (per 100,000 population) by age group, 2000 to 2004 combined, NDRS**



The average rate of *Campylobacter* infection was consistently higher among males over the five-year period (males: 38.96 per 100,000 population; females, 32.13 per 100,000 population). This trend is supported by findings reported in a study investigating the risk factors for *Campylobacter* infection in the United States [18].

## Exposure Settings for Outbreaks and Case Clusters

There were 11 outbreaks and case clusters related to *Campylobacter* and 177 outbreak-related laboratory-confirmed cases reported to the NML and NESP between 2000 and 2004. There were 116 confirmed cases of *Campylobacter* sp. that were associated with the *E.coli* O157:H7 outbreak in Walkerton, Ontario in 2000. The low number of outbreaks, case clusters and outbreak-related case counts is consistent with the considerable under-reporting of *Campylobacter* to the NESP, as well as the lack of an easily available and widely accepted typing scheme. Outbreaks and case clusters by exposure setting are shown in Table 17. Household settings represented the largest number of reported *Campylobacter* outbreaks, while one food service outbreak, linked to a deli counter at a local grocery store (40 cases) showed the highest outbreak related case counts among all other settings (excluding the Walkerton, Ontario outbreak).

**Table 17: *Campylobacter*-related outbreaks and case clusters (number of related cases reported) by exposure settings, 2000 to 2004, NML, NESP and PulseNet Canada**

| Setting | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| Community | 1 (116)* | - | 2 (4) | - | - |
| Food service | - | - | - | - | 1 (40) |
| Household | 3 (8) | - | 2 (4) | 2 (5) | - |
| **Total** | **4 (124)** | **0** | **4 (8)** | **2 (5)** | **1 (40)** |

* 116 confirmed cases of *Campylobacter* sp. were associated with the *E. coli* O157:H7 outbreak in Walkerton, Ontario

## Travel-acquired Infections

Between 2000 and 2004, 67 travel-acquired cases of *Campylobacter* were reported to the NESP. A history of travel was provided for approximately 1% of all *Campylobacter* infections reported to the NESP. Travel to Asia, Mexico and the Caribbean accounted for the majority of these infections (Table 18).

**Table 18: Number of travel-acquired *Campylobacter* infections by associated region/continent/country, 2000 to 2004, NESP**

| Region/Continent/Country | 2000 | 2001 | 2002 | 2003 | 2004 | Total # Per Region |
|---|---|---|---|---|---|---|
| Africa | 1 | - | - | 1 | 1 | **3** |
| Asia | 5 | 4 | 4 | 3 | 5 | **21** |
| Australia & Pacific | 1 | 1 | - | - | - | **2** |
| Central & South America | 1 | 1 | 1 | 1 | - | **4** |
| Europe | 2 | - | 2 | 1 | 2 | **7** |
| Mexico & Caribbean | 2 | 5 | 10 | 7 | - | **24** |
| United States | - | 1 | - | 1 | 1 | **3** |
| Multiple Regions | 2 | 1 | - | - | - | **3** |
| **Total** | **14** | **13** | **17** | **14** | **9** | **67** |

# Human Verotoxigenic *E. coli* Cases

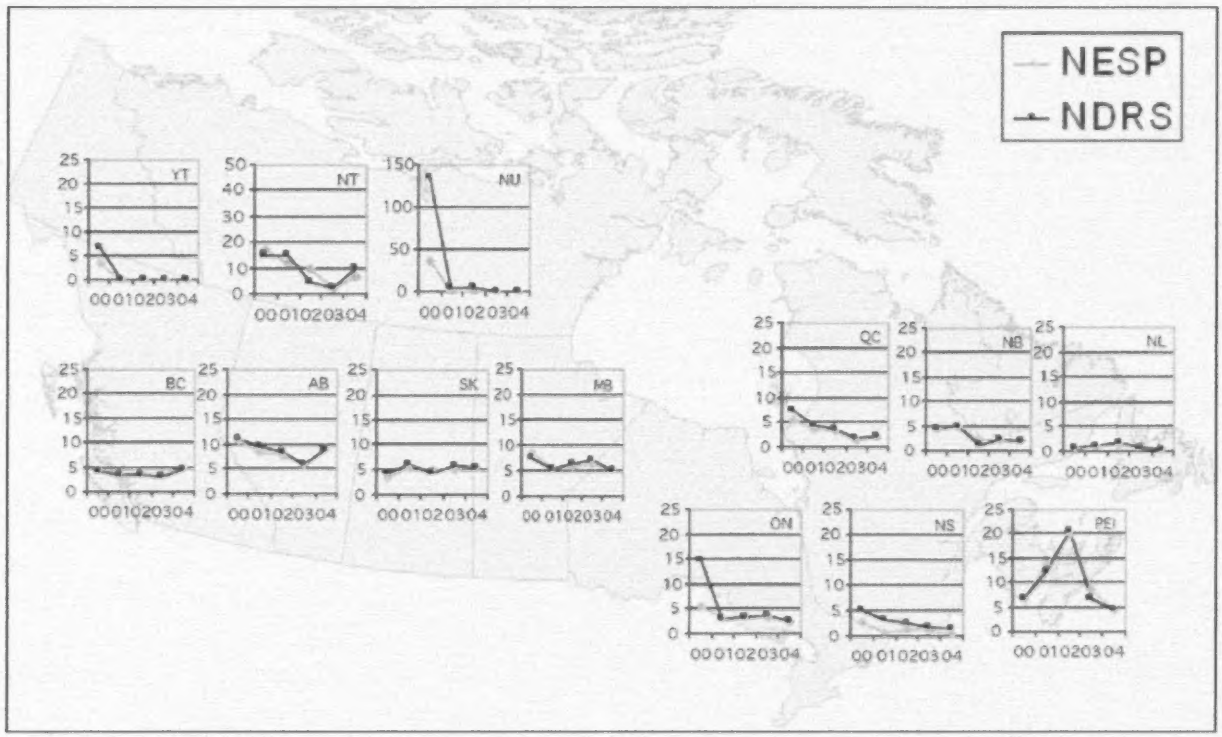
An overall decline in reported cases of verotoxigenic *E. coli* cases was observed after 2000 (Table 19). A slight increase in 2004 was related to an increase in reported cases in British Columbia and Alberta (Figure 29). A large number of cases were reported to NDRS in 2000 due to a waterborne outbreak of *E. coli* O157:H7 in Walkerton, Ontario. As a result, the province reported both lab-confirmed and epidemiologically-linked cases.

The rates derived from the NDRS and NESP data were similar (Figure 29). Although most provincial/territorial rates were fairly stable between 2000 and 2004, a slight decrease was noted in the eastern provinces, including: Ontario, Québec, New Brunswick, Nova Scotia, and Prince Edward Island. The large peak in Prince Edward Island in 2002 was attributable to *E. coli* outbreaks that occurred at a psychiatric hospital[19] and a daycare.

**Table 19: Number of verotoxigenic *E. coli* cases in Canada by year and surveillance system**

| | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| *NDRS* | 3011 | 1334 | 1243 | 1083 | 1103 |
| *NESP* | 1804 | 1286 | 1254 | 1031 | 1130 |

**Figure 29: Rates of verotoxigenic *E. coli* infections (per 100,000 population) as reported to the National Notifiable Disease Summary program (NDRS) and the National Enteric Surveillance Program (NESP) by province/territory, 2000 to 2004***




* Note the different scale used for Nunavat and the Northwest Territories.

## Verotoxigenic E. coli Serotypes

The majority (94%) of verotoxigenic *E. coli* infections reported to the NESP between 2000 and 2004 were serotype O157. The number of cases reported by serotype and year is listed in Table 20.

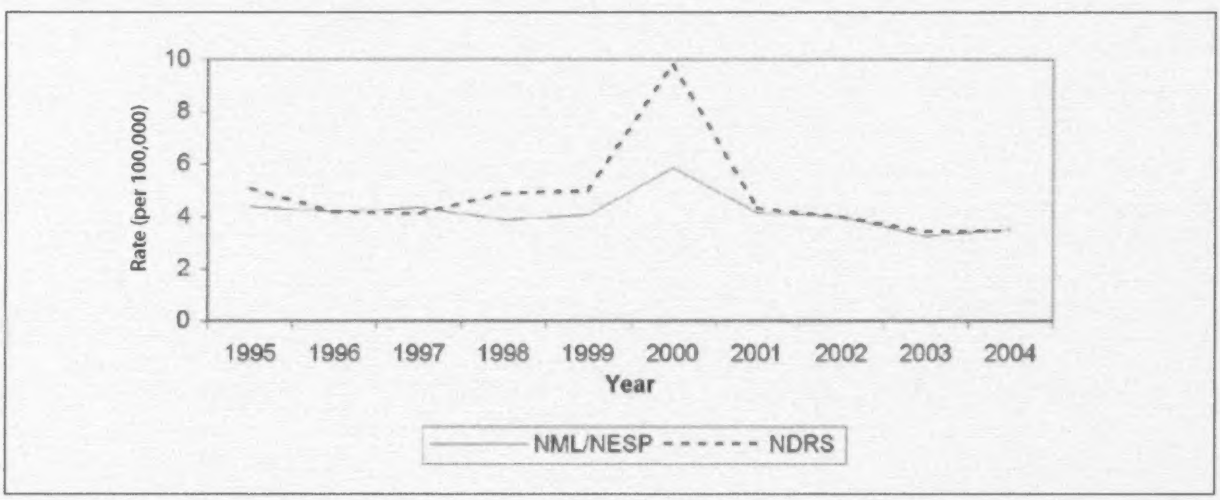
**Table 20: Number of verotoxigenic *E. coli* cases by serotype, 2000 to 2004, NESP**

| | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| O157 | 1718 | 1213 | 1194 | 952 | 1059 |
| Non-O157 | 41 | 32 | 46 | 70 | 64 |
| Non-specified | 45 | 41 | 14 | 9 | 7 |
| **Total** | **1804** | **1286** | **1254** | **1031** | **1130** |

## Long-term Trends

The national reporting rate of verotoxigenic *E. coli* infection steadily declined between 1995 and 2004, with the exception of a peak in 2000 that corresponded with a large waterborne outbreak in Walkerton, Ontario (Figure 30).

**Figure 30: Reported rates of verotoxigenic *E. coli* infections (per 100,000 population), 1995 to 2004, NDRS and NML/NESP***

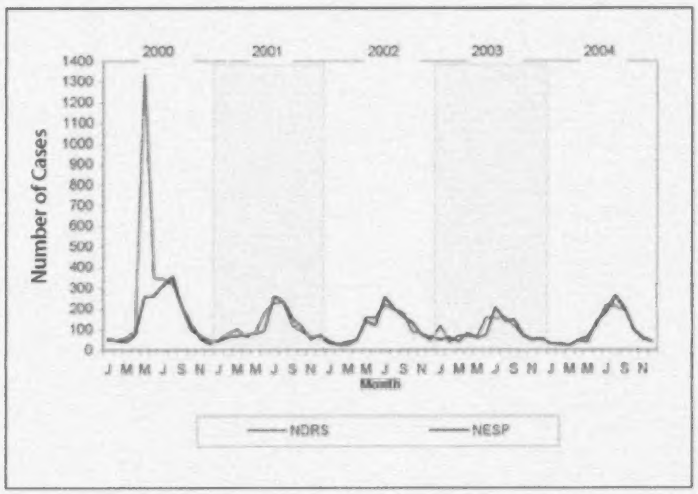



* NML data (1995-1997) include only *E. coli* O157 isolates received; NESP data (1998-2004) include *E. coli* O157 and other toxin-producing isolates reported.

## Monthly and Provincial/Territorial Trends

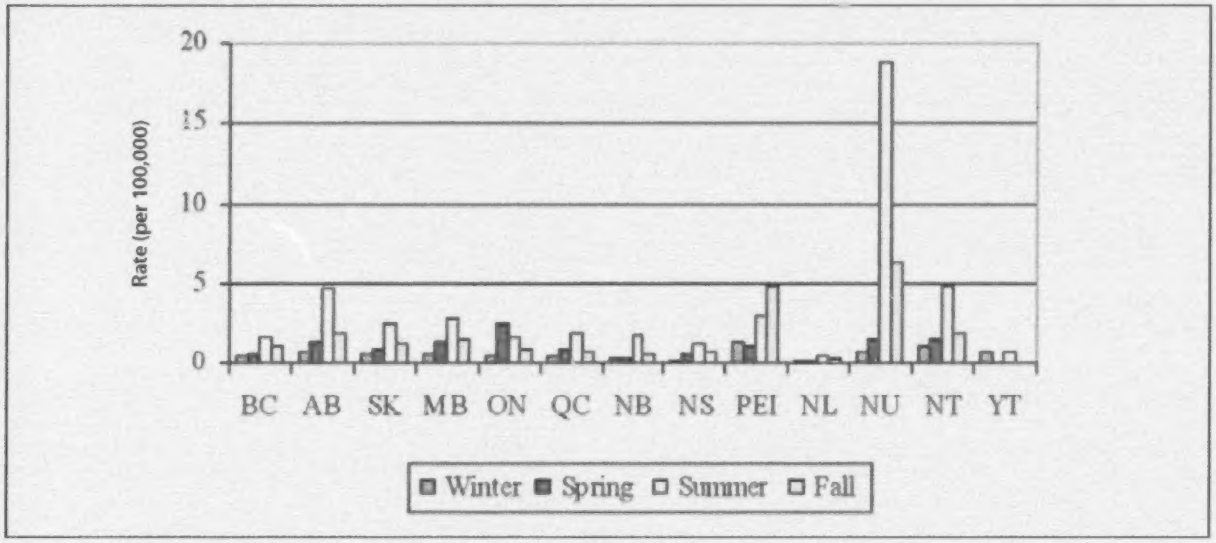
The seasonal trend of verotoxigenic *E. coli* cases shows a clear increase beginning in the spring, peaking in the summer and declining in the fall each year (Figure 31). In May 2000, the peak was due to the waterborne outbreak of *E. coli* O157:H7 in Walkerton, Ontario. Increased reporting observed in December 2001 was likely due to an outbreak related to catered events in Saskatchewan where more than 70 people were reported ill and 15 cases of *E. coli* O157:H7 PT 21 were confirmed. In May 2002, a cluster of more than 80 cases across Canada of *E. coli* O157:H7 PT 14a, was suspected to be linked to ground beef.

**Figure 31: Reported cases of verotoxigenic *E. coli* by month, 2000 to 2004, NDRS and NESP**




The seasonal variation in verotoxigenic *E. coli* rates by province/territory is shown in Figure 32. Summer peaks remained apparent across most provinces and territories, while the spring peak in Ontario and the fall peak in Prince Edward Island were largely due to specific outbreaks. The high rate in Nunavut in the summer reflects the 26 cases reported in 2000, several of them associated with the consumption of contaminated ground beef.

**Figure 32: Average reported rate of verotoxigenic *E. coli* infections (per 100,000 population per season*) by province/territory, 2000 to 2004, NDRS**



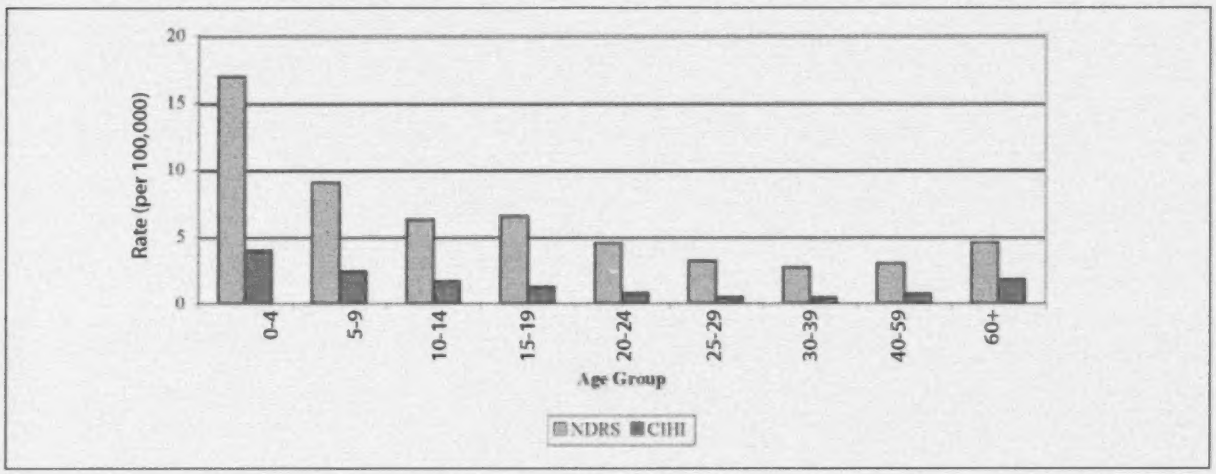

* Winter includes December, January and February; Spring includes March, April and May; Summer includes June, July and August; Fall includes September, October and November.

## Age and Gender Distribution

As with *Salmonella* and *Campylobacter*, infants and young children had the highest rate of infections and hospitalizations due to verotoxigenic *E. coli* (Figure 33). The rate progressively declines with increasing age, although it begins to increase again among the elderly.

The gender distribution for verotoxigenic *E. coli* infections remained fairly consistent over the five-year period, with a higher rate being reported in females (females: 5.48 per 100,000 population; males: 4.47 per 100,000 population). This trend is supported by findings reported in studies investigating the incidence of gastrointestinal illness in Canadian populations [20,21].

**Figure 33: Reported rate of verotoxigenic *E. coli* infections and hospitalizations (per 100,000 population) by age group, 2000 to 2004 combined, NDRS and CIHI**




## Exposure Settings for Outbreaks and Case Clusters

There were 129 outbreaks and case clusters related to verotoxigenic *E. coli* and 1196 outbreak-related laboratory-confirmed cases reported to the NML and NESP between 2000 and 2004. Outbreaks and case clusters of *E. coli* O157 by exposure setting are shown in Table 21. Household settings represented the largest number of reported outbreaks, while community settings resulted in higher outbreak-related case counts. The largest community outbreak occurred in May 2000, when the drinking water system in Walkerton, Ontario became contaminated with *E.coli* O157:H7 and *Campylobacter*. Seven deaths were associated with the outbreak, in four cases, the sole cause of death was *E.coli* infection as a result of the outbreak[22]. The investigation into the outbreak identified 1346 people that met the outbreak case definition which included both *E.coli* and *Campylobacter*[22]. Several outbreaks occurred in non-residential institutions including daycare settings. Person-to-person transmission and other risk factors unique to daycare settings may increase the potential for transmission and infection[23].

**Table 21: Verotoxigenic *E. coli*-related outbreaks and case clusters (number of related cases reported) by exposure settings, 2000 to 2004, NML, NESP and PulseNet Canada**

| Setting | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| Community | 7 (256) | 4 (38) | 4 (116) | 7 (93) | 9 (85) |
| Event/Function | - | - | 2 (48) | 2 (113) | 1 (7) |
| Food service | - | 2 (25) | 1 (2) | 1 (5) | 6 (149) |
| Household | 24 (60) | 12 (26) | 11 (30) | 7 (19) | 15 (40) |
| Institution-R* | 1 (2) | - | 1 (12) | - | - |
| Institution-NR* | 2 (9) | 2 (9) | 6 (37) | 1 (4) | 1 (11) |
| **Total** | **34 (327)** | **20 (98)** | **25 (245)** | **18 (234)** | **32 (292)** |

* R - residential and NR - non-residential

## Travel-acquired Infections

Only 10 cases of verotoxigenic *E. coli* reported to the NESP between 2000 and 2004 were identified as travel-related. A history of travel was provided for 10/6505 of *E. coli* infections reported to the NESP over the five-year period. Although foreign travel is one of the main risk factors for gastrointestinal illness, this information is rarely captured or reported and is therefore greatly under-represented in the NESP. Travel to Mexico and Caribbean countries accounted for half of the travel-acquired verotoxigenic *E. coli* infections recorded (Table 22).

**Table 22: Number of travel-acquired verotoxigenic *E. coli* infections by associated region/continent/country, 2000 to 2004, NESP**

| Region/Continent/Country | 2000 | 2001 | 2002 | 2003 | 2004 | Total # Per Region |
|---|---|---|---|---|---|---|
| Europe | - | - | 2 | - | 1 | **3** |
| Mexico & Caribbean | 1 | 1 | 1 | 1 | 1 | **5** |
| United States | - | 1 | - | 1 | - | **2** |
| **Total** | **1** | **2** | **3** | **2** | **2** | **10** |

# Human *Shigella* Cases

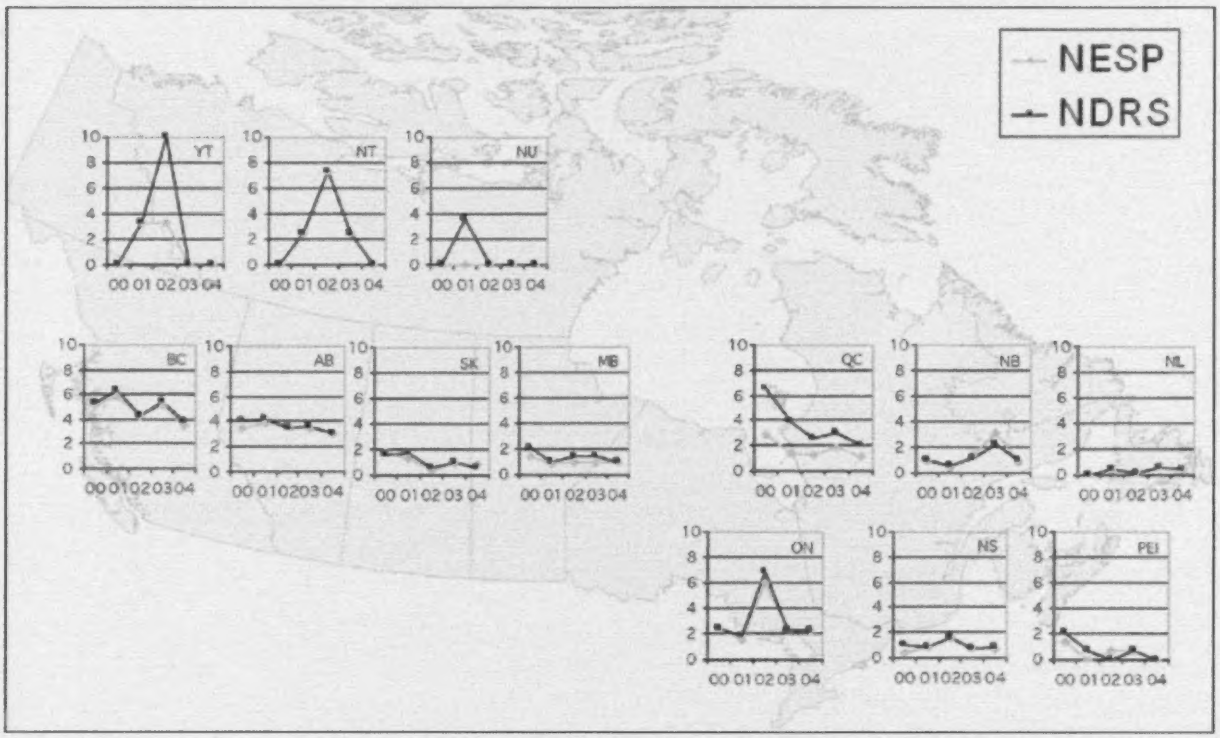
*Shigella* infections reported to the NDRS declined overall between 2000 and 2004, with the exception of a spike noted in 2002 (Table 23). The elevated case numbers in 2002 was due to an outbreak of *Shigella sonnei* in Ontario related to the consumption of a Greek-style pasta salad[24].

Rates of human *Shigella* captured in the NDRS and NESP by province/territory are shown in Figure 34 and were similar for all provinces. Most of the provinces reported an overall decrease in the number of cases, with Québec showing the steepest decline. The higher reported rates in Québec in 2000 were related to two community outbreaks, one in the northern region of the province and the other in a distinct ethnic community.

**Table 23: Number of *Shigella* cases in Canada by year and surveillance system**

| | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| *NDRS* | 1156 | 945 | 1355 | 906 | 720 |
| *NESP* | 855 | 692 | 1159 | 819 | 649 |

**Figure 34: Rates of shigellosis (per 100,000 population) as reported to the National Notifiable Disease Summary program (NDRS) and the National Enteric Surveillance Program (NESP) by province/territory, 2000 to 2004**



## Shigella *Species/Serotypes*

The distribution of *Shigella* cases by species, as reported to the NESP between 2000 and 2004, is shown in Table 24. The most frequently reported species were *S. sonnei* and *S. flexneri*. The total counts and ranking of the top five serotypes among *Shigella flexneri* cases are shown in Table 25. Serotype 2 was the most commonly reported type in each year.

**Table 24: *Shigella* species (number of cases), 2000 to 2004, NESP**

| | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| 1 | *S. sonnei* (561) | *S. sonnei* (463) | *S. sonnei* (885) | *S. sonnei* (526) | *S. sonnei* (319) |
| 2 | *S. flexneri* (209) | *S. flexneri* (158) | *S. flexneri* (204) | *S. flexneri* (201) | *S. flexneri* (250) |
| 3 | *S. boydii* (43) | *S. boydii* (31) | *S. boydii* (38) | *S. boydii* (41) | *S. boydii* (41) |
| 4 | *S. dysenteriae* (25) | *S. dysenteriae* (15) | *S. dysenteriae* (13) | *S. dysenteriae* (32) | *S. dysenteriae* (33) |
| | Not specified (17) | Not specified (25) | Not specified (19) | Not specified (19) | Not specified (6) |

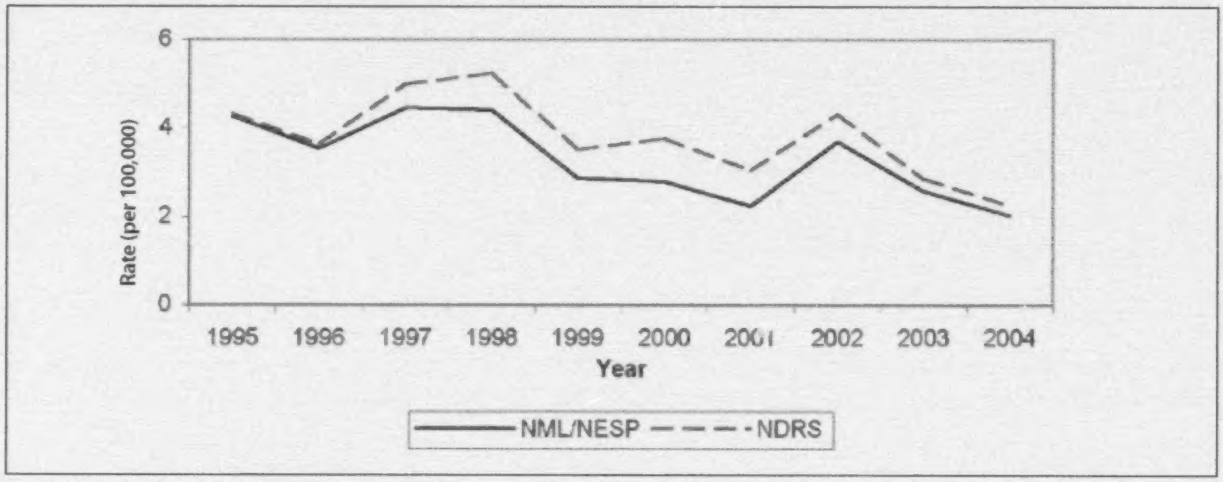
**Table 25: *Shigella flexneri* serotypes (number of cases), 2000 to 2004, NESP**

| | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| 1 | *S. flexneri 2* (42) | *S. flexneri 2* (51) | *S. flexneri 2* (41) | *S. flexneri 2* (25) | *S. flexneri 2* (30) |
| 2 | *S. flexneri 3* (24) | *S. flexneri 3* (12) | *S. flexneri 1* (18) | *S. flexneri 2a* (22) | *S. flexneri 2a* (19) |
| 3 | *S. flexneri 6* (23) | *S. flexneri 6* (12) | *S. flexneri 6* (18) | *S. flexneri 6* (16) | *S. flexneri 6* (17) |
| 4 | *S. flexneri 1* (8) | *S. flexneri 1* (9) | *S. flexneri 2a* (14) | *S. flexneri 1* (13) | *S. flexneri 3* (8) |
| 5 | *S. flexneri SH104* (8) | *S. flexneri SH104* (3) | *S. flexneri 3* (8) | *S. flexneri 3* (6) | *S. flexneri 3* (6) |
| | Other (12) | Other (5) | Other (24) | Other (30) | Other (23) |
| | Not specified (92) | Not specified (66) | Not specified (81) | Not specified (89) | Not specified (147) |

## *Long-term Trends*

Although annual rates fluctuated between 1995 and 2004, overall trends for human *Shigella* infections declined over this time period (Figure 35). The long-term reporting trends of *Shigella* cases from the NDRS and NML/NESP databases showed strong similarities.

**Figure 35: Reported rate of *Shigella* cases (per 100,000 population), 1995 to 2004, NDRS and NML/NESP**




* NML/NESP data includes totals from NML (1995-1997) and NESP (1998-2004).

## *Monthly and Provincial/ Territorial Trends*

The seasonal distribution of *Shigella* cases is less discernable than for *Salmonella*, *Campylobacter*, or verotoxigenic *E. coli* (Figure 36). In May 2002, a large outbreak of *Shigella sonnei* related to a Greek-style pasta salad occurred in Ontario [24]. Seasonal trends are more apparent when data is analyzed by province/territory, as shown in Figure 37. In several provinces and all territories, the rate of shigellosis was highest in the spring months. Overall, the rate of shigellosis was highest in British Columbia, Alberta and Québec.

**Figure 36: Reported cases of *Shigella* by month, 2000 to 2004, NDRS and NESP**

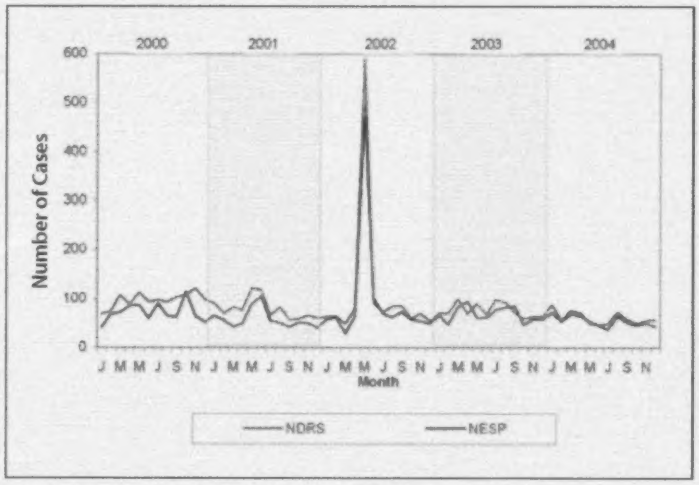
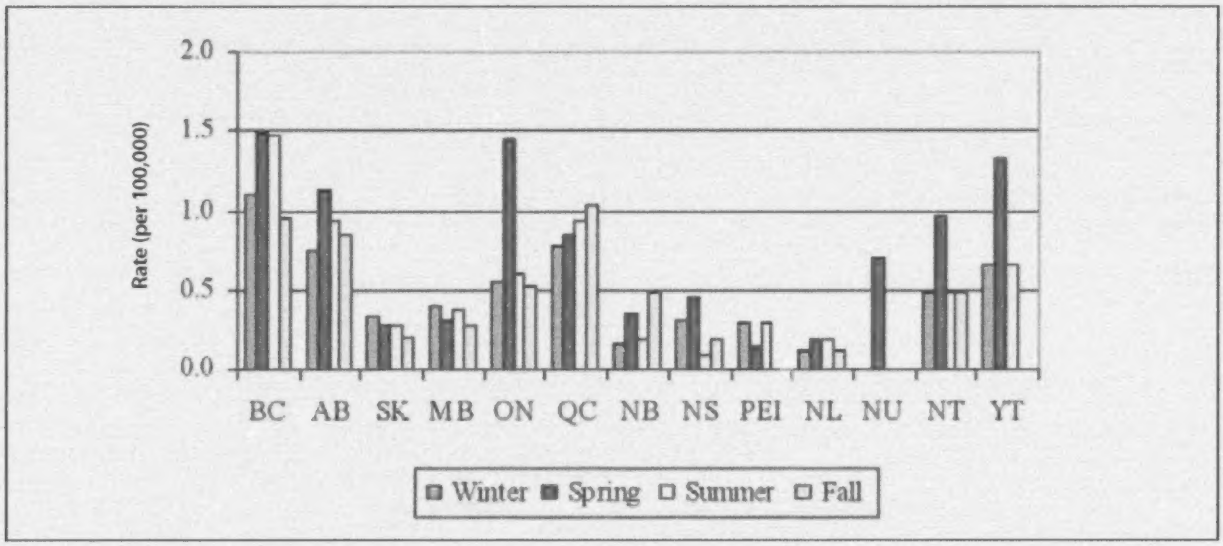


**Figure 37: Average reported rate of *Shigella* infections (per 100,000 population per season*) by province/territory, 2000 to 2004, NDRS**



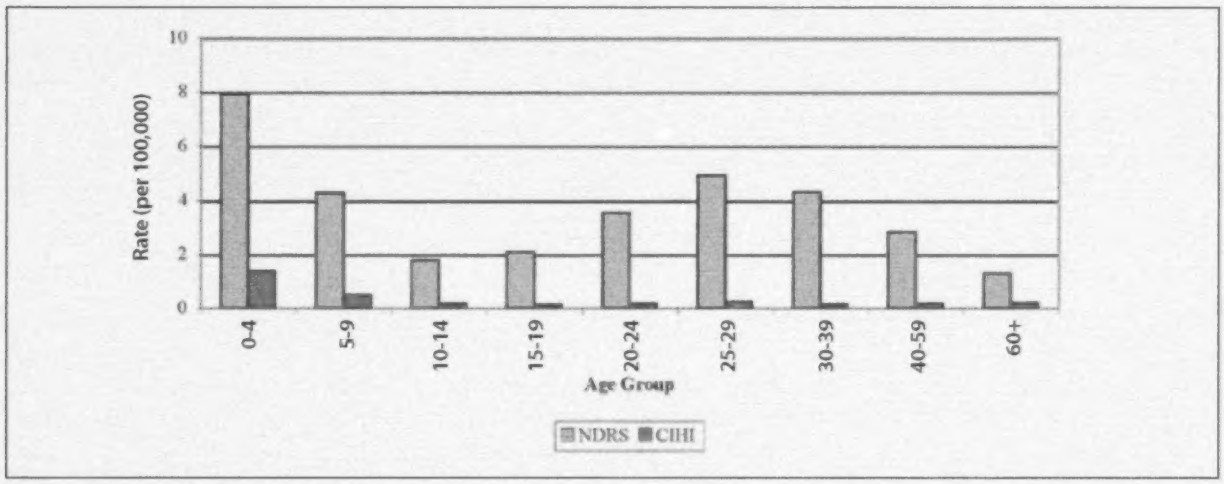

*Winter includes December, January and February; Spring includes March, April and May; Summer includes June, July and August; Fall includes September, October and November.

## Age and Gender Distribution

The age distribution of *Shigella* cases is shown in Figure 38. As was the case with *Salmonella*, *Campylobacter* and verotoxigenic *E. coli*, infants and young children experienced the highest rates of infection and hospitalizations. Higher rates of shigellosis were also seen in 20 to 59 year olds, although hospitalization rates (CIHI) for this group were comparatively low. The higher rates in this adult age group may represent parents with young children having a greater exposure to this pathogen [25] or the potential for sexual transmission among men who have sex with men [26].

No apparent trend was observed in the gender distribution for *Shigella* cases between 2000 and 2004.

**Figure 38: Reported rate of *Shigella* ca..es and hospitalizations (per 100,000 population) by age group, 2000 to 2004 combined, NDRS and CIHI**




## Exposure Settings for Outbreaks and Case Clusters

There were 35 outbreaks and case clusters related to *Shigella* and 698 outbreak-related laboratory-confirmed cases reported to the NML and NESP between 2000 and 2004. Eighty percent of these were associated with *S. sonnei*. Only seven household clusters and 15 related cases were linked to either *S. boydii*, *S. dysenteriae* or *S. flexneri* during this period.

Outbreaks and case clusters by exposure setting are shown in Table 26. Household settings represented the largest number of reported *Shigella* outbreak and case clusters, while community settings resulted in higher outbreak related case counts, marked by the more than 420 cases associated with the greek-style pasta salad outbreak in 2002 in Ontario.

**Table 26: *Shigella*-related outbreaks and case clusters (number of related cases reported) by exposure settings, 2000 to 2004, NML, NESP and PulseNet Canada**

| Setting | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| Community | 3 (121) | 3 (34) | 1 (426) | 5 (28) | - |
| Event/Function | - | - | - | 1 (12) | - |
| Food service | - | - | - | 1 (15) | 1 (2) |
| Household | 3 (6) | 3 (6) | 5 (10) | 5 (11) | 2 (5) |
| Institution-R* | 1 (4) | - | - | - | - |
| Institution-NR* | 1 (6) | - | - | 1 (12) | - |
| **Total** | **8 (137)** | **5 (40)** | **6 (436)** | **13 (78)** | **3 (7)** |

* R - residential and NR - non-residential

## Travel-acquired Infections

Between 2000 and 2004, 162 travel-acquired *Shigella* infections were reported to the NESP. A history of travel was reported for approximately 4% of *Shigella* infections reported to the NESP. Travel-related *Shigella* infections were mainly due to travel to Asia, Mexico and the Caribbean (Table 27).

**Table 27: Number of travel-acquired *Shigella* infections by associated region/continent/country, 2000 to 2004, NESP**

| Region/Continent/Country | 2000 | 2001 | 2002 | 2003 | 2004 | Total # Per Region |
|---|---|---|---|---|---|---|
| Africa | 9 | 2 | 2 | 10 | 3 | **26** |
| Asia | 6 | 4 | 11 | 10 | 11 | **42** |
| Central & South America | - | 3 | 5 | 3 | 4 | **15** |
| Europe | - | - | 1 | - | - | **1** |
| Mexico & Caribbean | 5 | 6 | 26 | 20 | 14 | **71** |
| Multiple Regions/Unknown | 3 | 2 | - | 1 | 1 | **7** |
| **Total** | **23** | **17** | **45** | **44** | **33** | **162** |

# Hospitalizations, Deaths and Unusual Isolation Sites

## Hospitalizations and Deaths

Hospitalizations due to *Salmonella*, *Campylobacter*, pathogenic *E. coli*, and *Shigella*, between 2000 and 2004 are shown in Table 28. Although hospitalization data are recorded in the NDRS, only one province reported hospitalized cases over this period, thus the data were not included. *Salmonella* and pathogenic *E. coli* was associated with the highest hospitalization rates per 1000 cases over all five years.

**Table 28: Hospitalization data by pathogen, 2000 to 2004, CIHI**

| | Year | Number of cases hospitalized | Hospitalization rate (per 1,000 enteric hospitalizations)† |
|---|---|---|---|
| *Salmonella* (Non-typhoid) | 2000 | 824 | 33.67 |
| | 2001 | 861 | 26.12 |
| | 2002 | 891 | 14.91 |
| | 2003 | 743 | 11.12 |
| | 2004 | 729 | 10.16 |
| *Salmonella* Typhi and Paratyphi | 2000 | 61 | 2.49 |
| | 2001 | 97 | 2.94 |
| | 2002 | 102 | 1.71 |
| | 2003 | 78 | 1.17 |
| | 2004 | 105 | 1.46 |
| *Campylobacter* (ICD-10 only) | 2000 | N/A | N/A |
| | 2001 | 105 | N/A |
| | 2002 | 419 | N/A |
| | 2003 | 352 | N/A |
| | 2004 | 349 | N/A |
| Pathogenic *E. coli* | 2000 | 607 | 24.80 |
| | 2001 | 443 | 13.44 |
| | 2002 | 383 | 6.41 |
| | 2003 | 235 | 3.52 |
| | 2004 | 320 | 4.46 |
| *Shigella* | 2000 | 101 | 4.13 |
| | 2001 | 92 | 2.79 |
| | 2002 | 78 | 1.30 |
| | 2003 | 70 | 1.05 |
| | 2004 | 73 | 1.02 |

† Hospitalizations where the diagnostic code indicated that the enteric pathogen was detected. See Appendix A – Section 6 for enteric pathogens included in denominator.

*The four digit code required to specify *Campylobacter* was not consistently used.

The number of deaths associated with *Salmonella*, *Campylobacter*, pathogenic *E. coli* and *Shigella* infections are shown in Table 29. Although captured in the NDRS, deaths due to these four enteric diseases were only reported by two provinces, consequently the data are not shown. The number of deaths according to the Vital Statistics database (Statistics Canada) is included for comparison purposes. *Salmonella* infections resulted in the most deaths in both CIHI and Vital Statistics databases. *Salmonella* and pathogenic *E. coli* accounted for the highest death rates per 1000 hospitalized with illness, over the five-year period. One *S.* Paratyphi case resulting in a death was recorded in 2003 in the Vital Statistics Database, while no deaths were recorded from CIHI data over the five-year time period for *S.* Typhi or *S.* Paratyphi.

**Table 29: Deaths associated with enteric infections, 2000 to 2004, CIHI and Vital Statistics (Statistics Canada)**

| | | CIHI Database | | Vital Statistics Database | |
|---|---|---|---|---|---|
| | Year | Number of Deaths (CIHI) | Death rate (per 1000 hospitalized with illness)* | Number of Deaths (Vital Stats)** | Death Rate (per 1000 cases)‡ |
| *Salmonella* | 2000 | 5 | 6.07 | 3 | 0.52 |
| | 2001 | 10 | 11.61 | 1 | 0.16 |
| | 2002 | 8 | 8.98 | 6 | 0.99 |
| | 2003 | 9 | 12.11 | 8 | 1.54 |
| | 2004 | 14 | 19.20 | 5 | 0.96 |
| | **Total** | **46** | **11.36** | **23** | **0.81** |
| *Campylobacter** | 2000 | N/A | N/A | 1 | 0.08 |
| | 2001 | 1 | 9.52 | 1 | 0.08 |
| | 2002 | 0 | 0 | 1 | 0.09 |
| | 2003 | 0 | 0 | 0 | - |
| | 2004 | 3 | 8.52 | 1 | 0.10 |
| | **Total** | **4** | **3.26** | **4** | **0.07** |
| *Pathogenic E. coli* | 2000 | 5 | 8.24 | 6 | 1.99 |
| | 2001 | 2 | 4.51 | 1 | 0.75 |
| | 2002 | 6 | 15.67 | 3 | 2.41 |
| | 2003 | 1 | 4.26 | 2 | 1.85 |
| | 2004 | 4 | 12.50 | 2 | 1.82 |
| | **Total** | **18** | **8.55** | **14** | **1.80** |
| *Shigella* | 2000 | 0 | 0 | 0 | - |
| | 2001 | 0 | 0 | 1 | 1.06 |
| | 2002 | 0 | 0 | 0 | - |
| | 2003 | 1 | 14.29 | 0 | - |
| | 2004 | 0 | 0 | 1 | 1.39 |
| | **Total** | **1** | **2.42** | **2** | **0.39** |

†Hospitalized with infection that was indicated in the CIHI database as a contributing factor in their death.
*The four digit code required to specify *Campylobacter* was not consistently used.
** Deaths in the Vital Statistics database include only those for which these organisms were the principle cause of death.
‡ Calculated as the number of deaths in Vital Stats/number of reports in NDRS

## Unusual Isolation Sites

The number of isolates collected from unusual sites (i.e. non-faecal specimens) reported to the NESP between 2000 and 2004, is shown in Table 30. Although information regarding unusual isolation sites is collected by the NESP, this data is not consistently reported to provincial or central reference labs. Of the four enteric disease pathogens discussed in this report, *Salmonella* accounted for the majority of isolations from non-faecal sources. Over the five-year period, there was an increase in unusual isolation sites from which *Salmonella* was cultured. The top three *Salmonella* serovars isolated from blood included, S. Typhi (19% of all S. Typhi; 107/563), S. Paratyphi A (14% of all S. Paratyphi A; 39/270), and S. Heidelberg (7% of S. Heidelberg; 303/4690).

**Table 30: Number of isolates collected from unusual isolation sites (i.e. non-faecal), by pathogen, 2000 to 2004, NESP**

| Pathogen | Site | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|
| *Salmonella* (Non-typhoid) | Blood | 73 | 68 | 135 | 153 | 148 |
| | Urine | 36 | 61 | 59 | 94 | 74 |
| | Other | 8 | 13 | 8 | 16 | 11 |
| | **Total #** | **117** (5618) | **142** (6168) | **202** (6009) | **263** (5160) | **233** (5109) |
| | **Total %** | **2%** | **2%** | **3%** | **5%** | **5%** |
| *Salmonella* Typhi and Paratyphi | Blood | 18 | 17 | 25 | 53 | 46 |
| | Urine | 2 | - | 4 | 2 | 2 |
| | Other | - | - | 1 | - | - |
| | **Total #** | **20** (162) | **17** (215) | **30** (247) | **55** (251) | **48** (269) |
| | **Total %** | **12%** | **8%** | **12%** | **32%** | **18%** |
| *Campylobacter* | Blood | 1 | 3 | 2 | 2 | 5 |
| | Urine | - | - | - | - | - |
| | Other | - | - | - | - | - |
| | **Total #** | **1** (1994) | **3** (1718) | **2** (1807) | **2** (1529) | **5** (1305) |
| | **Total %** | **>1%** | **>1%** | **>1%** | **>1%** | **>1%** |
| Vertoxigenic *E. coli* | Blood | - | 1 | 1 | - | - |
| | Urine | - | - | - | 1 | - |
| | Other | - | - | - | - | - |
| | **Total #** | **0** (1837) | **1** (1333) | **1** (1284) | **1** (1063) | **0** (1164) |
| | **Total %** | **0%** | **>1%** | **>1%** | **>1%** | **0%** |
| *Shigella* | Blood | 2 | - | 2 | 2 | 1 |
| | Urine | 3 | 1 | 1 | - | - |
| | Other | - | - | - | - | - |
| | **Total #** | **5** (855) | **1** (692) | **3** (1159) | **2** (819) | **1** (649) |
| | **Total %** | **>1%** | **>1%** | **>1%** | **>1%** | **>1%** |

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# Appendix A: Data Sources

This section describes the data sources used to generate the integrated report.

Data on human cases for this report were derived from:

- National Notifiable Diseases Reporting System (NDRS) database
- Enteric Diseases Program, National Microbiology Laboratory (NML) database
- PulseNet Canada – PulseNet Canada Database
- National Enteric Surveillance Program (NESP) database
- Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS)
- Hospital Morbidity Database (HMDB) from the Canadian Institute for Health Information (CIHI)
- Death Database -Vital Statistics from Statistics Canada

Data on isolates from non-human sources were obtained from:

- Laboratory for Foodborne Zoonoses (LFZ)
- Includes non-human isolates from CIPARS (Abattoir and Retail Food Components)

## Section 1

Data in the **National Notifiable Disease Reporting System** (NDRS) database includes data that are collected on a mandatory basis by the local public health units/authorities. These data were reported through the provincial/territorial Ministries of Health to the Infectious Disease and Emergency Preparedness Branch of the Public Health Agency of Canada (PHAC) for inclusion in the NDRS.

Data are submitted in case-level or aggregate form. Case-level data includes "confirmed" (laboratory identification of pathogen) and "closed" (investigation completed) reports. Eight provinces and territories provided case-level data, though completeness of data fields and values varied by region. However, disease, province and date were available for all. Date information varied from the date of diagnosis to the date the report was received. Other optional data included age, sex, and risk factor information such as travel and mode of transmission. Aggregate-level data are available from all provinces and territories in Canada. Information was aggregated by disease (e.g. Salmonellosis), age group, sex, year and month, and no case level information was included. Provincial/territorial counts reflected the introduction of Nunavut in April of 1999. All data were verified at the provincial/territorial level. This involved summarizing monthly reports into an annual report that was sent back to the originating jurisdiction for verification. Once updated and approved, the data were returned to the PHAC. These data are then made available on the web at Notifiable Disease Online at **http://dsol-smed.phac-aspc.gc.ca/dsol-smed/ndis/index_e.html**.

## Section 2

Data supplied by the **Enteric Diseases Program, National Microbiology Laboratory** (NML - formerly called the National Laboratory for Bacteriology and Enteric Pathogens) are primarily from the provincial public health and reference laboratories as well as from work performed at the NML. Local and regional laboratories forwarded some enteric pathogen isolates to provincial laboratories for confirmation and identification. Some isolates from the provincial laboratories were sent to the NML for reference services, such as

confirmation and further strain characterizations. Provincial laboratories also sent aggregate information for all notifiable enteric agents observed each month to the NML. Both the aggregate and case level datasets included: organism, province, species, serovar/serotype, source (only human source data included in this report), isolate source (e.g. stool, urine), travel information, outbreak information when available, and age and gender. Additionally, both contained date information, but in the aggregate dataset this was the reporting date, and in the non-aggregate data set, the date of isolation was reported. Further details from these data are available from annual summaries [Laboratory Surveillance Data for Enteric Pathogens in Canada, 2000-2004 Annual Summaries (**http://nml-lnm.gc.ca/english/NESP.htm**)].

The **National Enteric Surveillance Program (NESP)** is a surveillance system that is jointly managed by the Centre for Food-borne, Environmental and Zoonotic Infectious Diseases (CFEZID) and the Enteric Diseases Program, National Microbiology Laboratory (NML) of the Public Health Agency of Canada, in co-operation with provincial public health and central reference laboratories (PHLs). The system receives weekly aggregate totals of new identifications on a select group of enteric organisms from the PHLs in order to provide weekly national analyses and reports. A broad range of bacterial, viral and parasitic diseases identified to the species or serovar level is tracked in this program. National coverage was established in April 1997 and 1998 marked the first full calendar year of data collection. Therefore, only data from 1998 onwards were used for this report. These data included counts by week and species or serovar for each province and territory. Additional information on antimicrobial resistance, outbreaks and case clusters, unusual isolation sites and travel were also reported, when available.

## Section 3

### Outbreaks and Case Clusters Data

The outbreak and case cluster data includes information collected through various surveillance systems, including the NML, NESP and PulseNet Canada, as well as from investigations in which the NML and CFEZID had provided assistance. The NESP defines case clusters as a group of cases that represent higher than expected incidence in time and/or space but with no or weak epidemiologic linkages established. An outbreak is defined as a group of cases that represent higher than expected incidence in time and/or space and for which an investigation is undertaken to determine source of the infections. There is currently no national outbreak reporting system and therefore outbreak data may not be representative of all of the outbreaks that have occurred in Canada during this period. As well, the case counts reported may not represent the final case distribution and may not reflect the total number of cases associated with the outbreaks. Although outbreak-related data for cases are captured in the NDRS, there is no unique identifier linking outbreak-related cases and, as with the NML/NESP, total outbreak-related case counts may not reflect actual final case counts.

**Exposure Setting Description** (NESP and NML data)

Community outbreaks included unrelated cases (i.e. no common household or institutional event) with similar illness that can be epidemiologically-linked (i.e. associated by time and/or place and/or exposure). For events and private functions, cases of infection are related to groups of individuals with common exposure to specific events (e.g. banquets, weddings, parties). Food service outbreaks are related to food establishments (e.g. restaurant, cafeteria, bakery) and/or the commercial distribution of prepared meals. Household clusters generally involve small numbers of immediate family

members and friends and may include cases of secondary transmission or may be related to larger community or other events. A residential institution is a place where individuals reside under the care of staff for short or long periods of time (e.g. nursing home, hospital). Non-residential institutional settings include daycare centres, schools, colleges/universities, etc. Travel-related outbreaks occurring within Canada are included here, but clusters of cases related to foreign travel are not.

## Section 4

The **Canadian Integrated Program for Antimicrobial Resistance Surveillance** (CIPARS), initiated in 2002, is a national program dedicated to the collection, integration, analysis and communication of trends in antimicrobial use and the development of resistance in selected bacterial organisms from human, animal and food sources across Canada. The program is based on several representative and methodologically unified surveillance components that can be linked to examine the relationship between antimicrobials used in food-animals and humans and the associated health impacts. From 2002 to 2004, CIPARS activities included the operation of: two active surveillance components, including: 1) abattoir surveillance involving the collection and analysis of isolates of generic *E. coli* and *Salmonella* from the intestinal contents of healthy animals at slaughter across Canada; and 2) retail surveillance involving the collection and analysis of isolates of generic *E. coli*, *Salmonella*, and *Campylobacter* from retail meat in Ontario and Québec. The program also collected passive surveillance data on antimicrobial resistance (AMR) in *Salmonella* isolates from human and diseased animal specimens collected from laboratories across Canada. For this report, only human and non-human *Salmonella* isolates collected between 2002 and 2004 were included.

The *Surveillance of Human Clinical Isolate* component of CIPARS is designed to provide representative data on *Salmonella* isolates at the provincial level. All human *Salmonella* isolates received by the provincial public health laboratories in New Brunswick, Newfoundland, Nova Scotia, Manitoba, Prince Edward Island, and Saskatchewan are forwarded to the National Microbiology Laboratory of the Public Health Agency of Canada in Winnipeg, Manitoba. More populated provinces (Alberta, British Columbia, Ontario, and Québec) forward isolates received from the first to the 15$^{th}$ of each month. In addition, all human isolates of *S.* Newport and *S.* Typhi are forwarded to the National Microbiology Laboratory because of concerns of emerging multidrug resistance and clinical importance, respectively.

## Section 5

The **Laboratory for Foodborne Zoonoses** (LFZ) data included *Salmonella* isolates from non-human sources that were submitted to their facility for testing. This laboratory serves as a national centre for serotyping *Salmonella* from non-human sources. For this report, isolates from research projects and quality assurance programs were excluded. Included in the report were data from environmental assessment or food quality programs (e.g. supply flocks, exportation, quality monitoring), veterinary diagnostic submissions, as well as from the abattoir and retail components of the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) (See CIPARS description above). Isolates were received from provincial veterinary laboratories, other federal laboratories, university laboratories, private laboratories as well as agencies investigating outbreaks. There were inconsistency in the submission of isolates during the time period covered by this report as the types of samples and regional distribution varied from year to year. Routine data collected for each record

included isolate source, type of sample, species or product, submitting laboratory, specimen number, date of collection, province, county or municipality, establishment, program, priority, serovar, phagetype, and biochemical characteristics. Further details from these data are available from annual summaries [Laboratory Surveillance Data for Enteric Pathogens in Canada, 2000 to 2004 Annual Summaries (**http://nml-lnm.gc.ca/english/NESP.htm**)].

## Section 6

The **Hospital Morbidity Database** (HMDB) from **CIHI** captures administrative, clinical and demographic information on hospital inpatients from acute care facilities and some chronic care and rehabilitation facilities across Canada. For this report, records were selected in which the following enteric pathogens were indicated in the first three diagnostic codes from the International Statistical Classification of Diseases and Related Health Problems, Ninth Revision and Tenth Revision (ICD-9 and ICD-10): Cholera (001.0-001.9 and A000, A001 and A009), Typhoid/Paratyphoid (002.0-002.9 and A010-A014), *Salmonella* (003.0-003.9 and A020-A029), *Shigella* (004.0-004.9 and A030-A039), Other Food Poisoning (005.0-005.9 and A050-A059), Amebiasis (006.0-006.9 and A060-A069), Other Protozoal Intestinal Diseases (007.0-007.9 and A071-A079), pathogenic *E. coli* (008.0 and A040-A044) Other Organisms (008.1-008.8 and A046-A049), Gastrointestinal Anthrax (022.2 and A222), Listeriosis (027.0 and A32), and Viral Hepatitis A (007.0-007.1 and A080-A085). Only the first four numbers of the ICD-9 were available and therefore the data were not specific enough for the analysis of *Campylobacter* infections. In ICD-10, *Campylobacter* is coded as A045, therefore only the ICD-10 counts are presented in the report. Records from CIHI are given by fiscal year but the data were analysed by calendar year. Key variables included diagnostic codes, age, sex, province/territory, and exit code (e.g. discharged or death).

## Appendix B: National Notifiable Diseases: Enteric, Food and Waterborne Diseases, 2000 to 2004[1]

- Botulism
- Campylobacteriosis
- Cholera
- Cryptosporidiosis
- Cyclosporiasis
- Giardiasis
- Hepatitis A
- Salmonellosis
- Shigellosis
- Typhoid
- Verotoxigenic *Escherichia coli* Infection